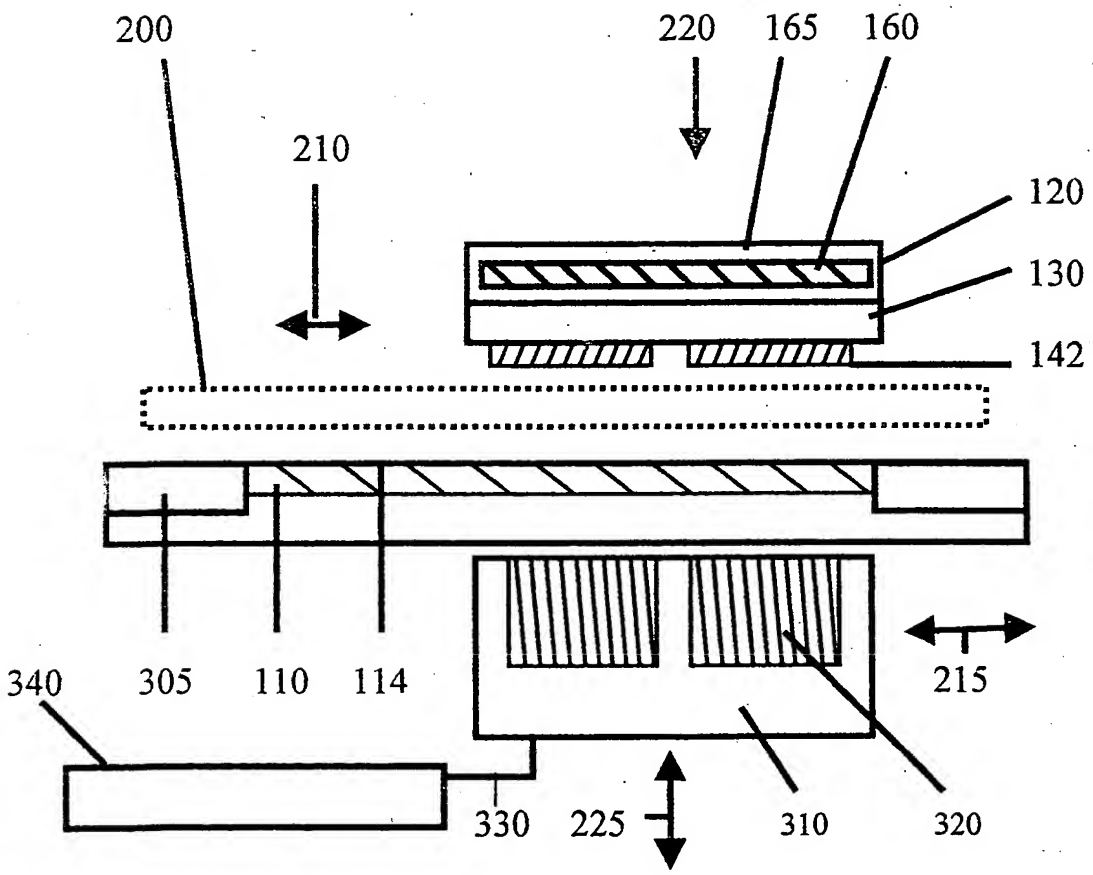
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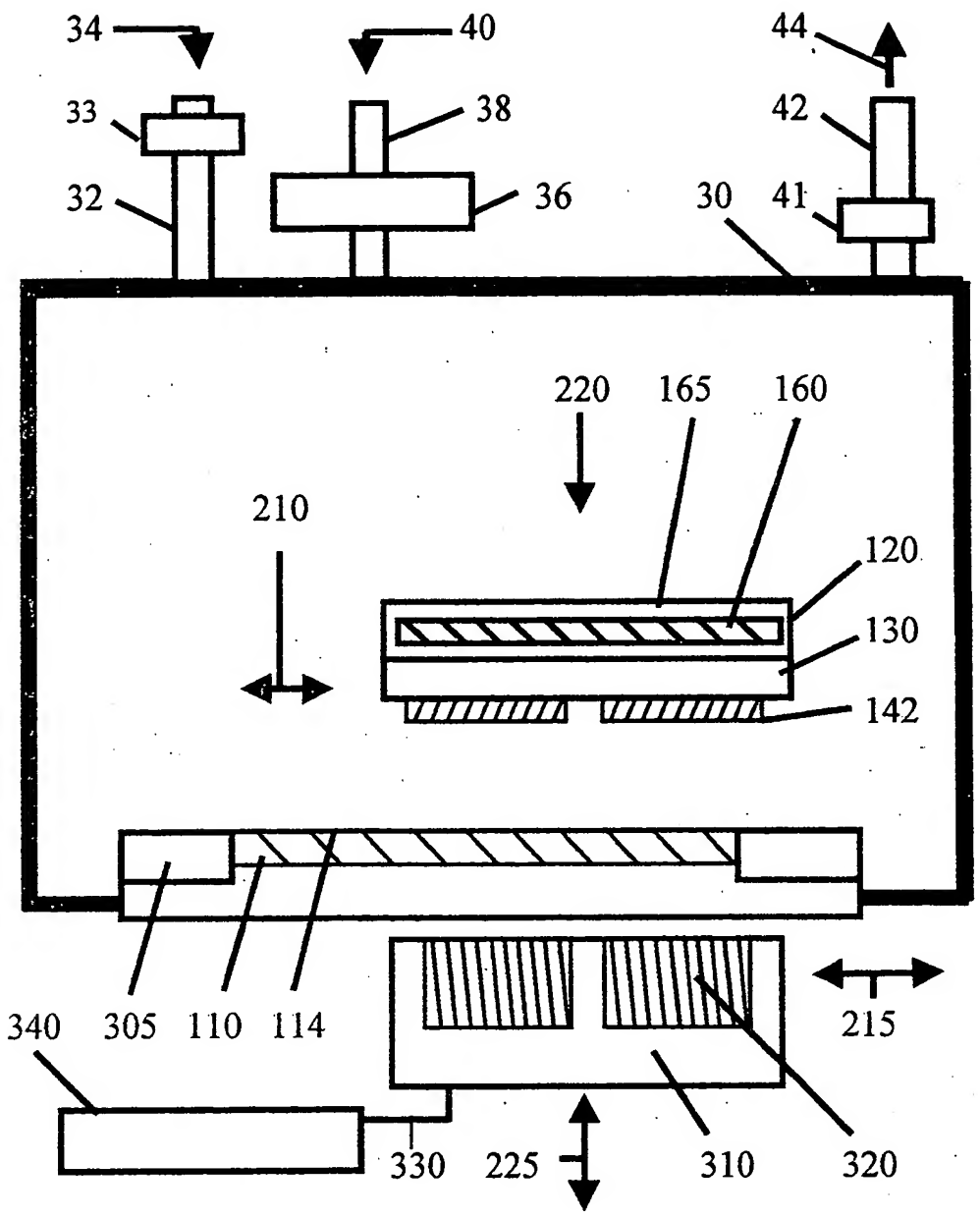
210
120
130
142
340
305
110
114
215
330
225
310
320

Figure 1a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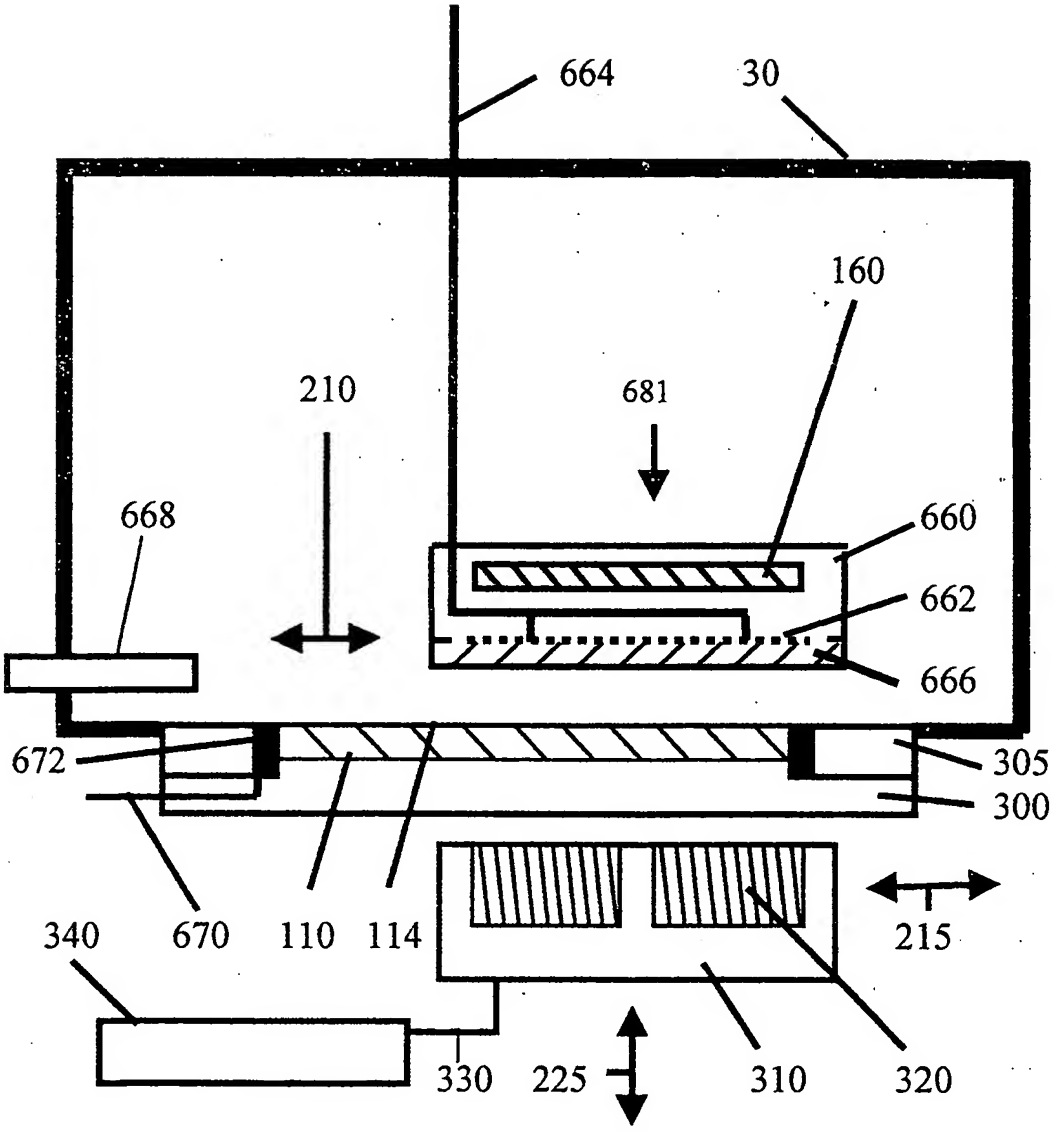
114
215
330
225
310
320

Figure 1b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670
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114
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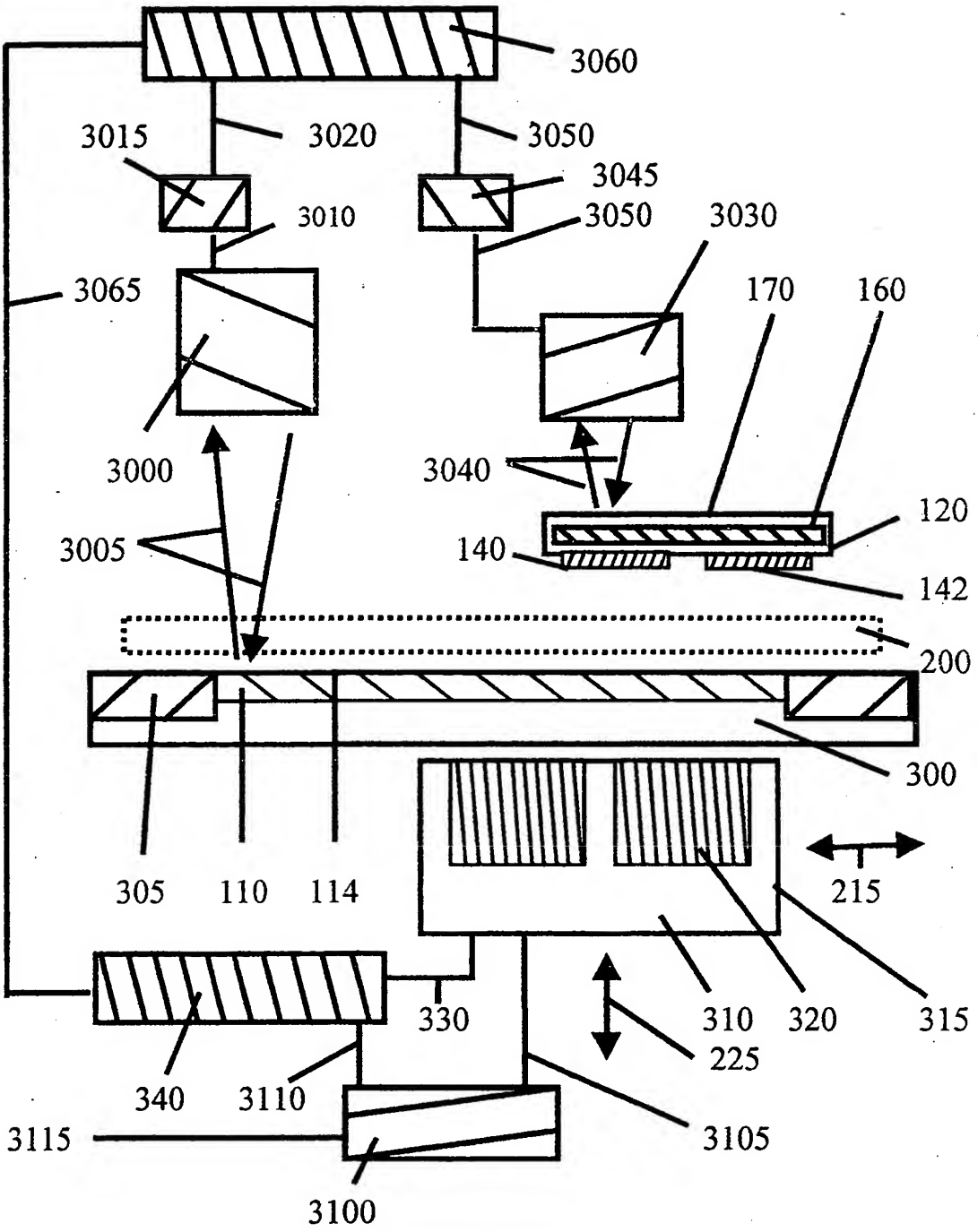
225
310
320

Figure 1c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3010
3050
3030
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170
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3000
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120
3005
140
142
200
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310
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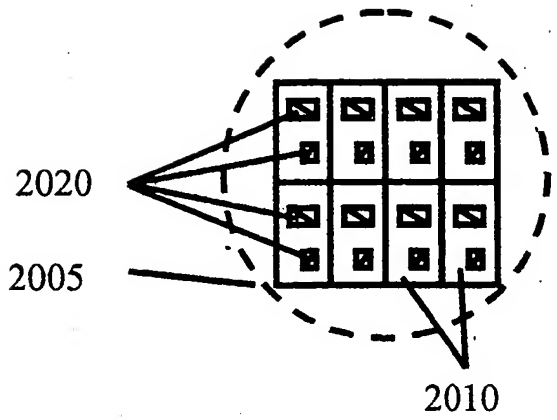
225
340
3110
3105
3115
3100

Figure 2

Figure 3a



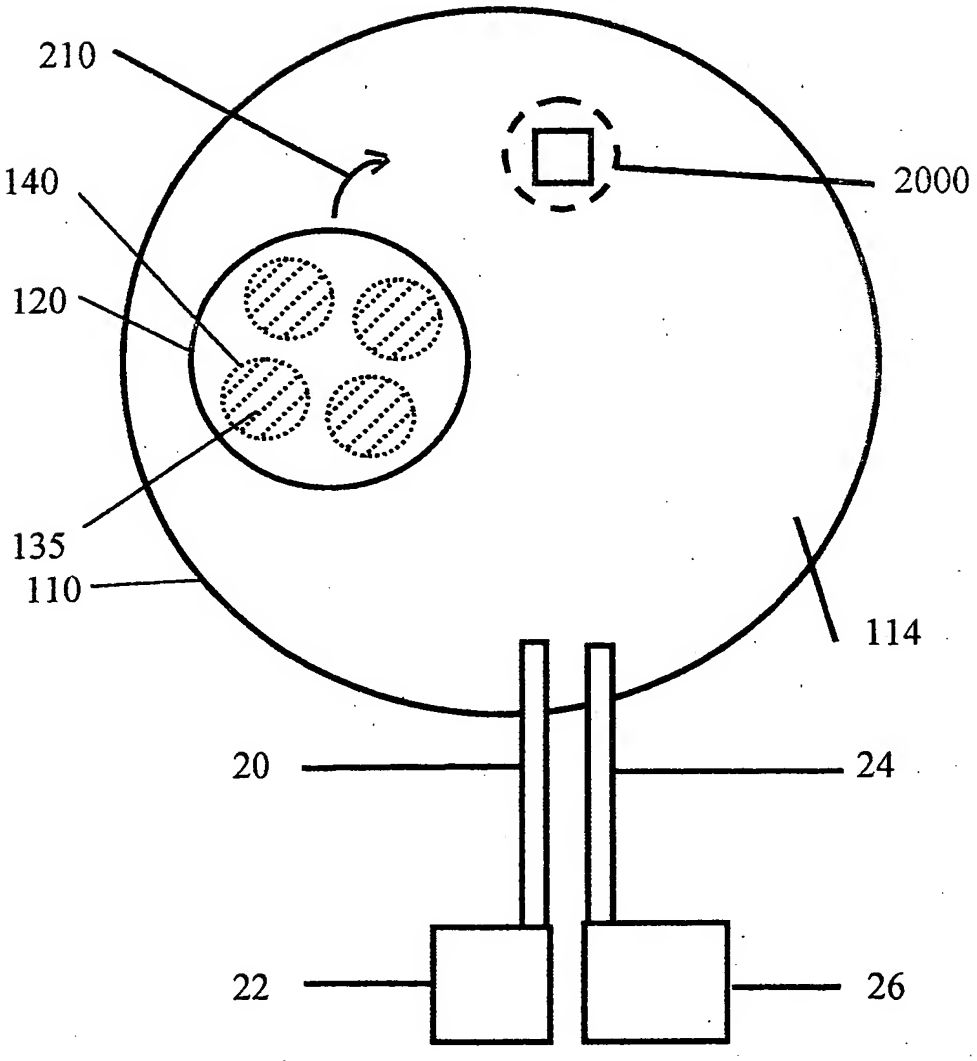


Figure 3

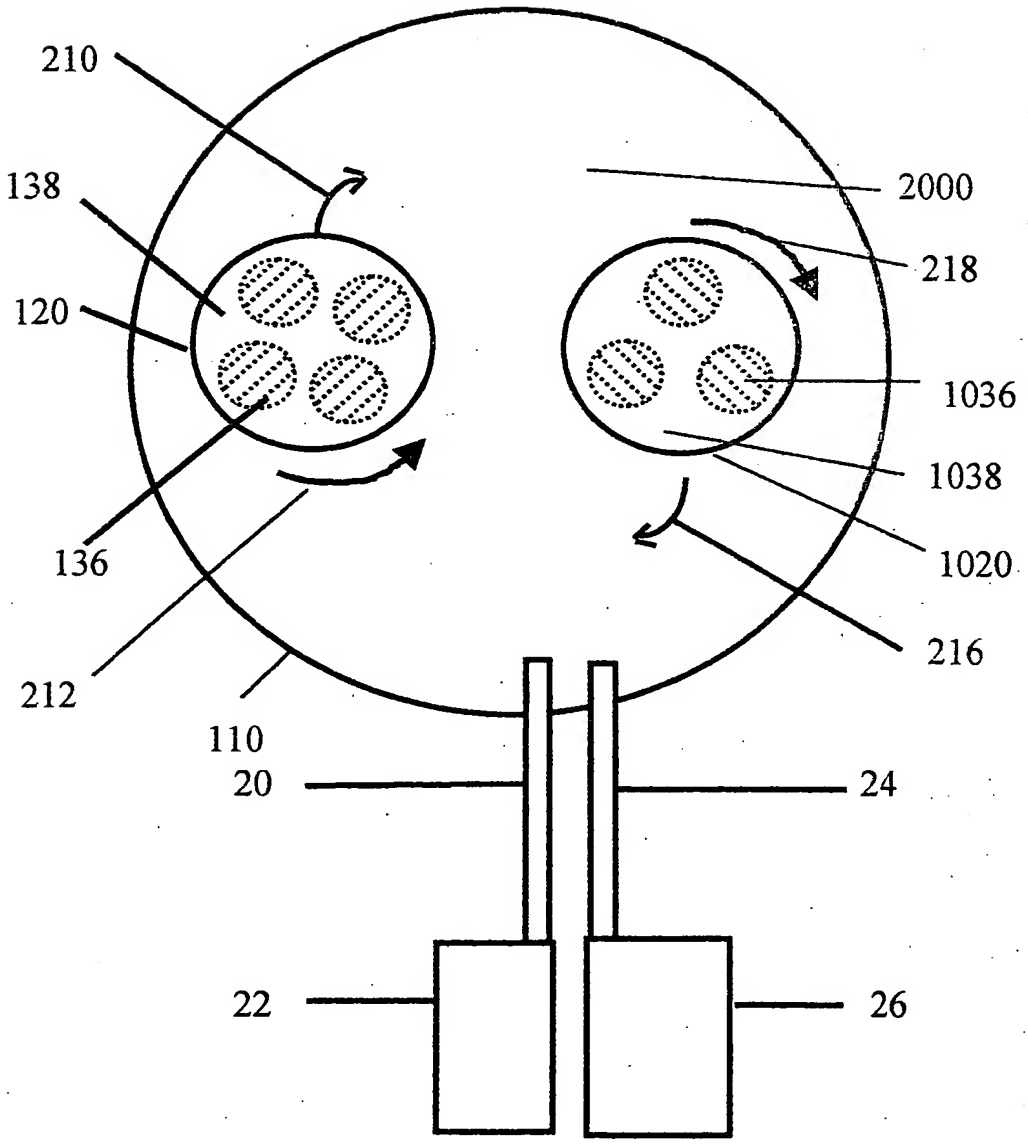


Figure 4

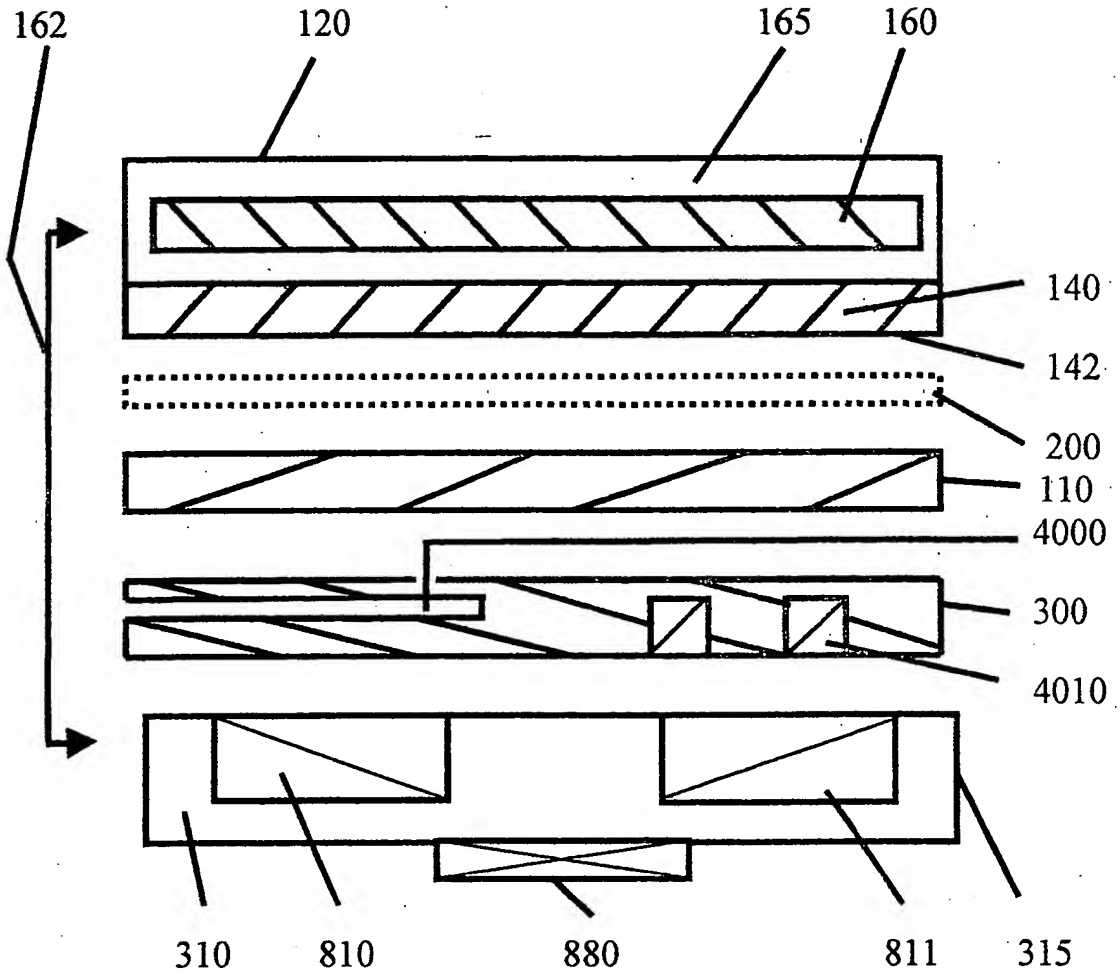

162
120
165
160
140
142
200
110
4000
300
4010
310
810
880
811
315

Figure 5

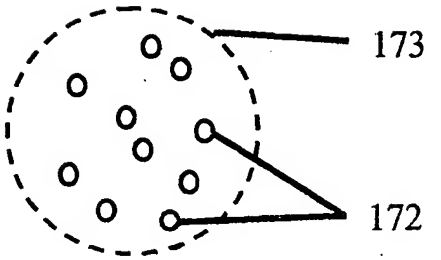


Figure 6b

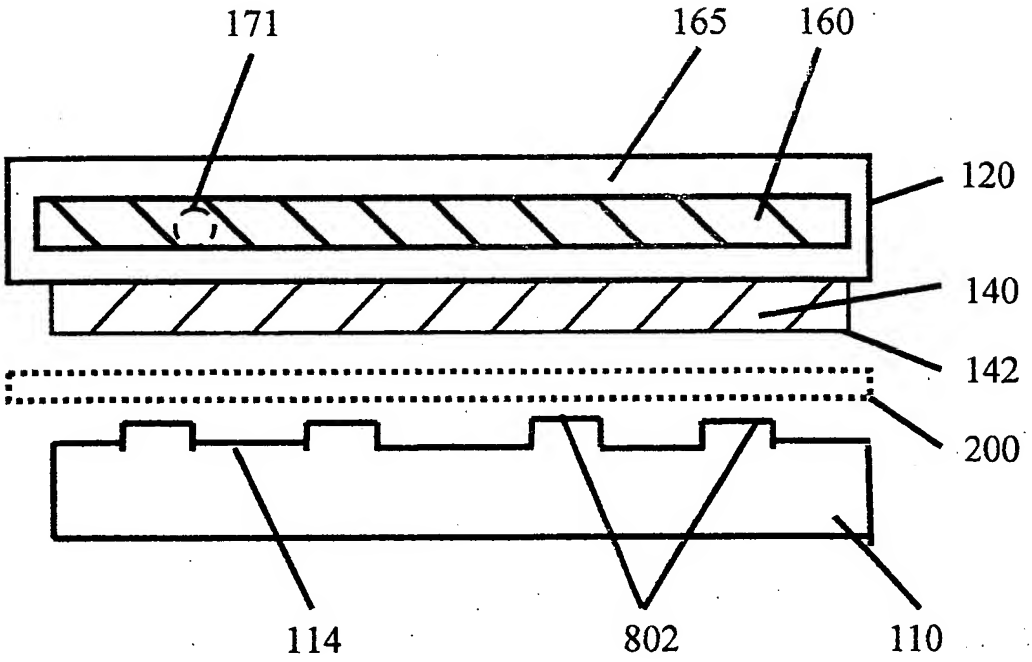


Figure 6

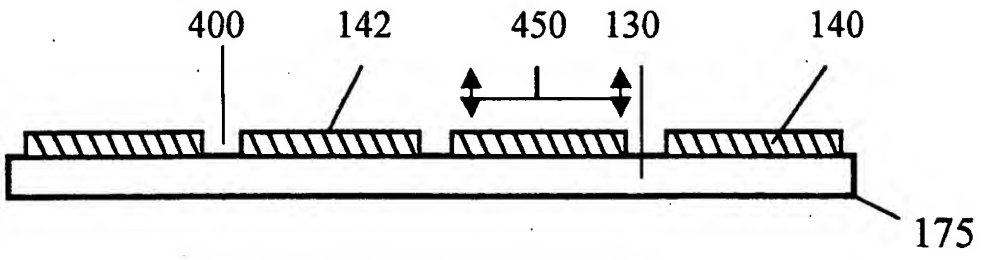


Figure 7a

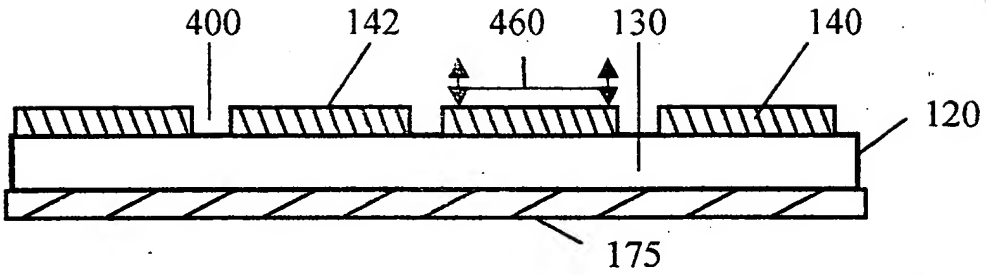


Figure 7b

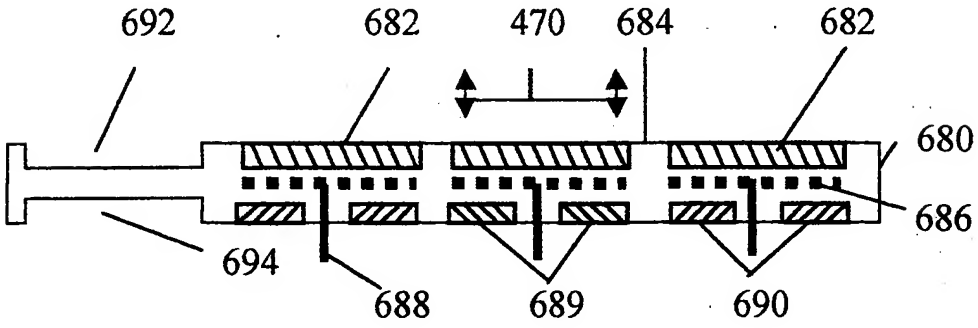


Figure 7c

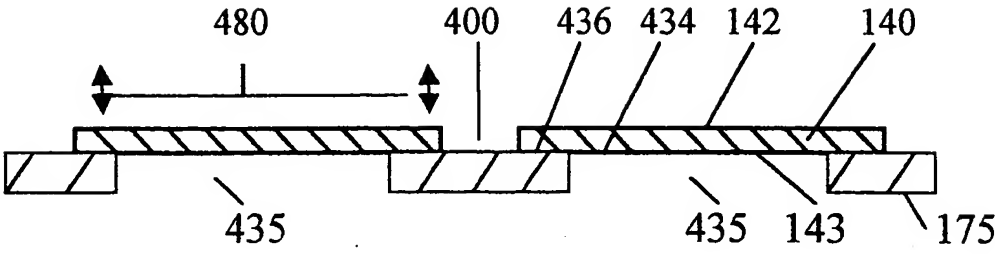


Figure 8a

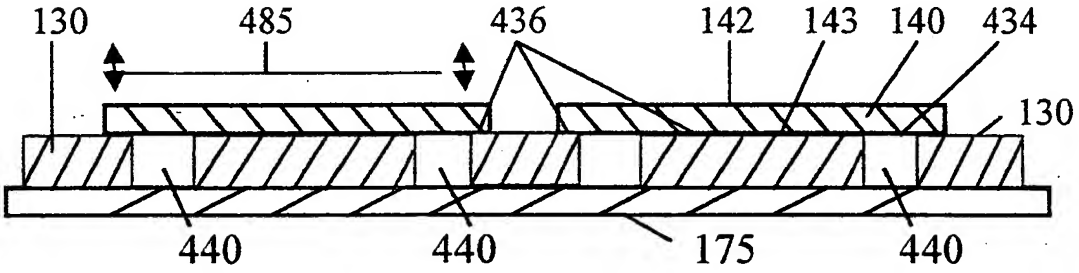


Figure 8b

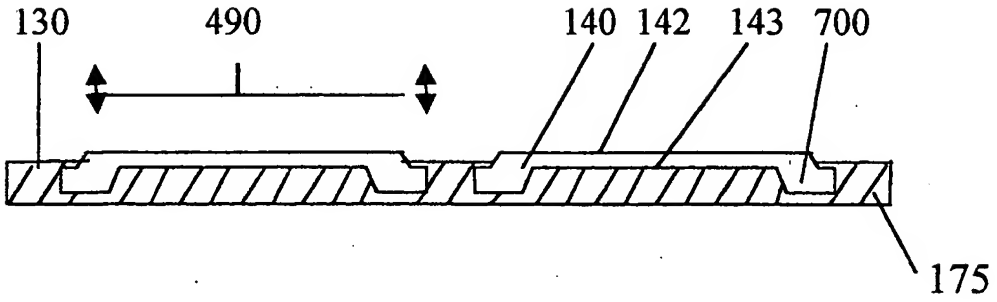


Figure 9a

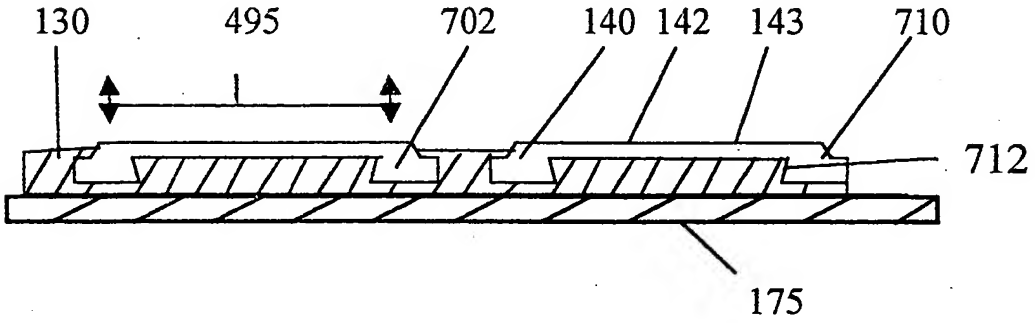


Figure 9b

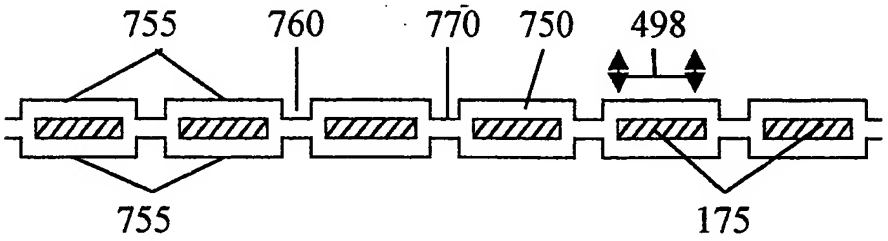


Figure 9c

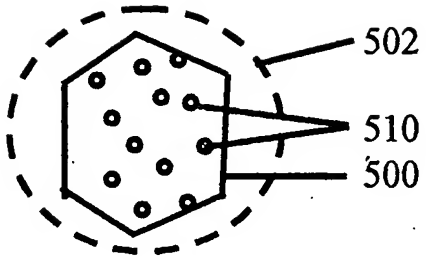


Figure 10aa

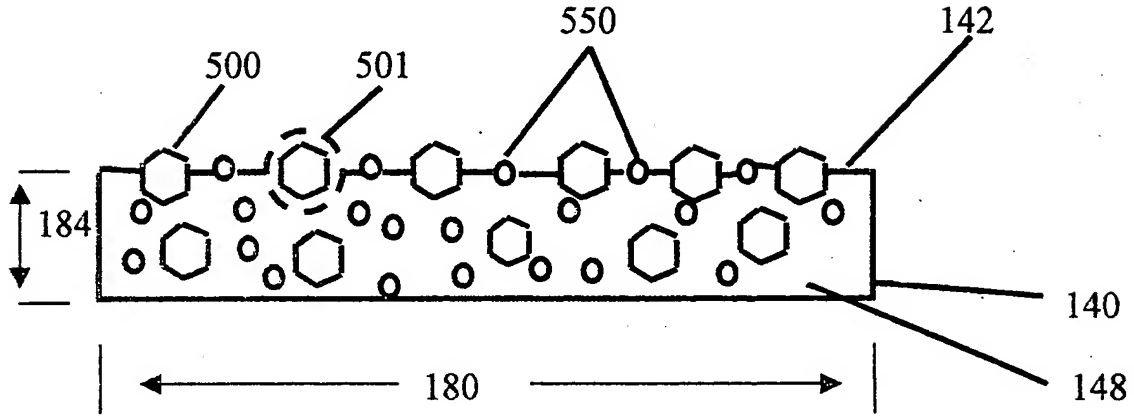


Figure 10a

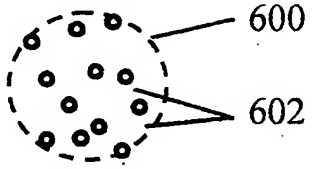


Figure 10bb

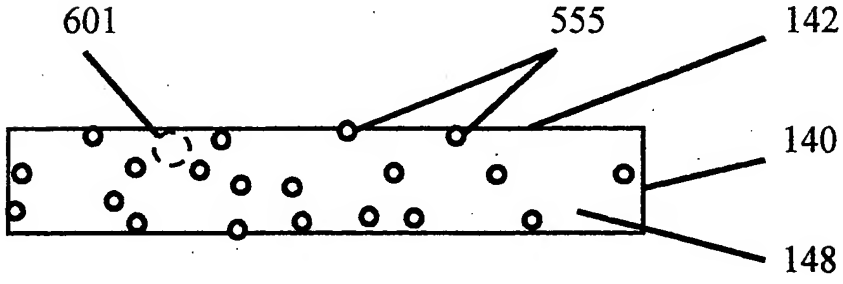


Figure 10b

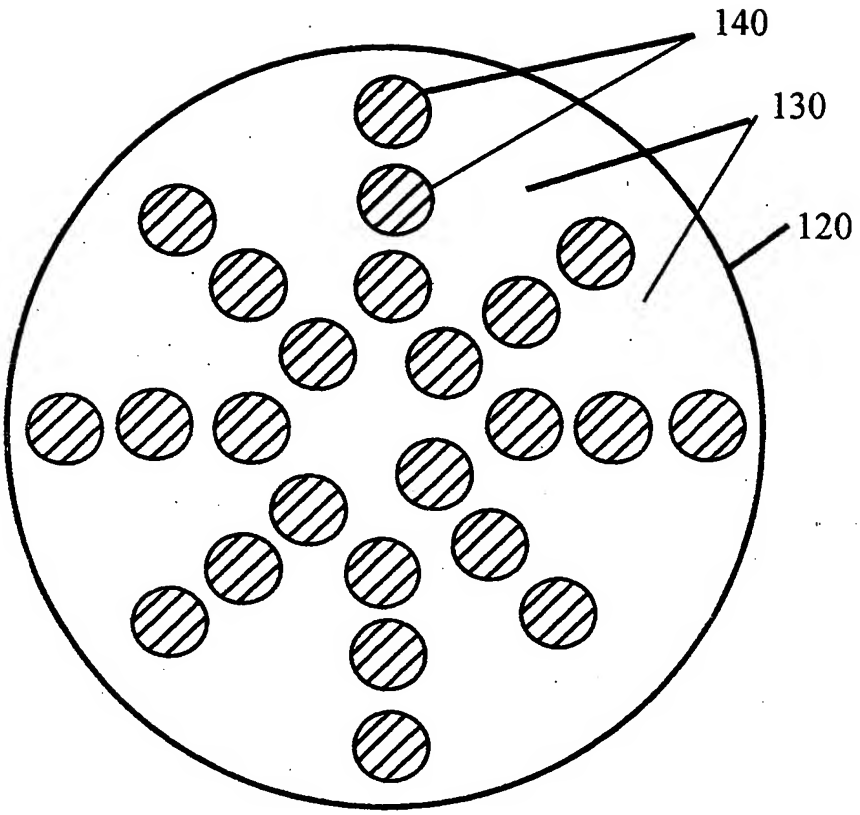


Figure 11

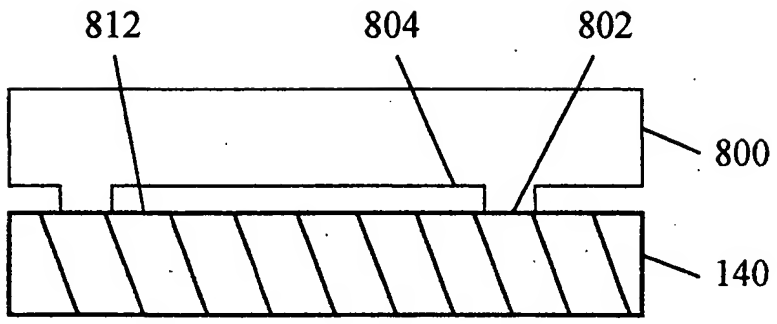


Fig. 12a

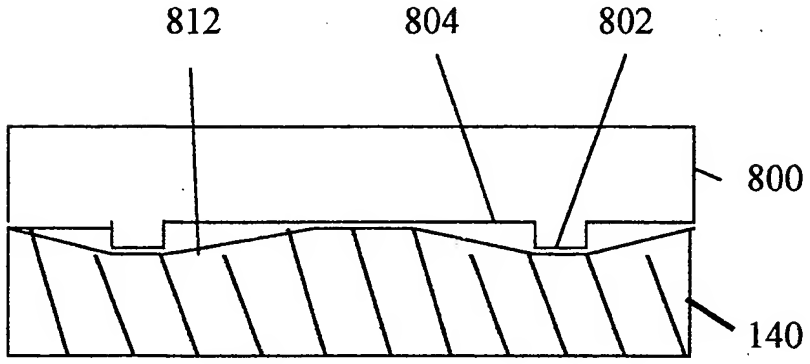


Fig. 12b

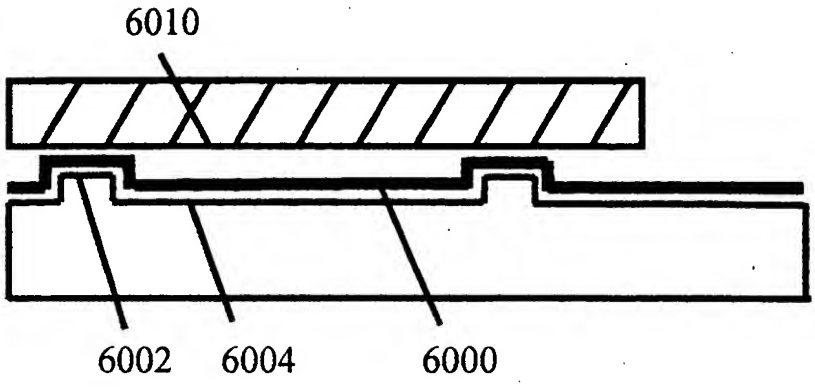


Figure 12c

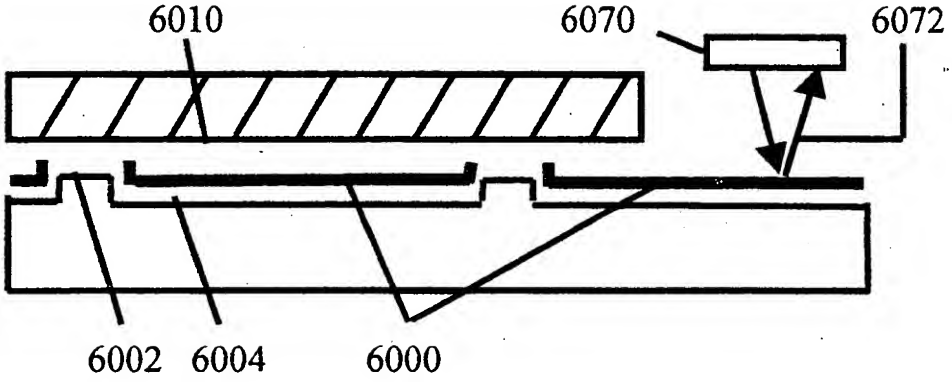


Figure 12d

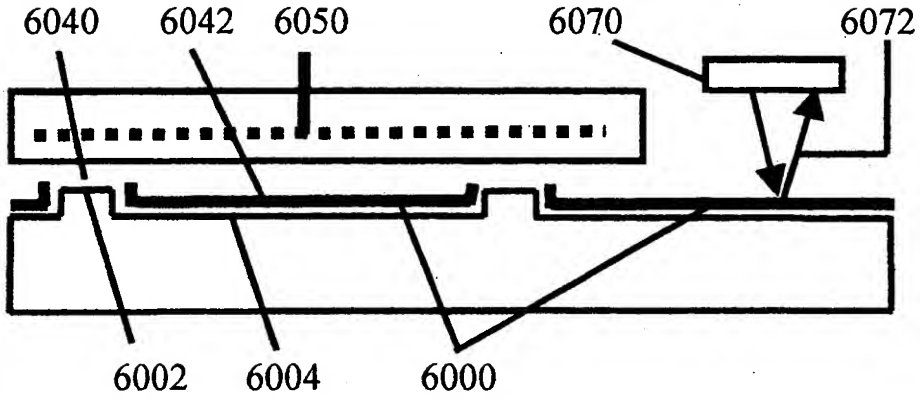


Figure 12e

Figure 13

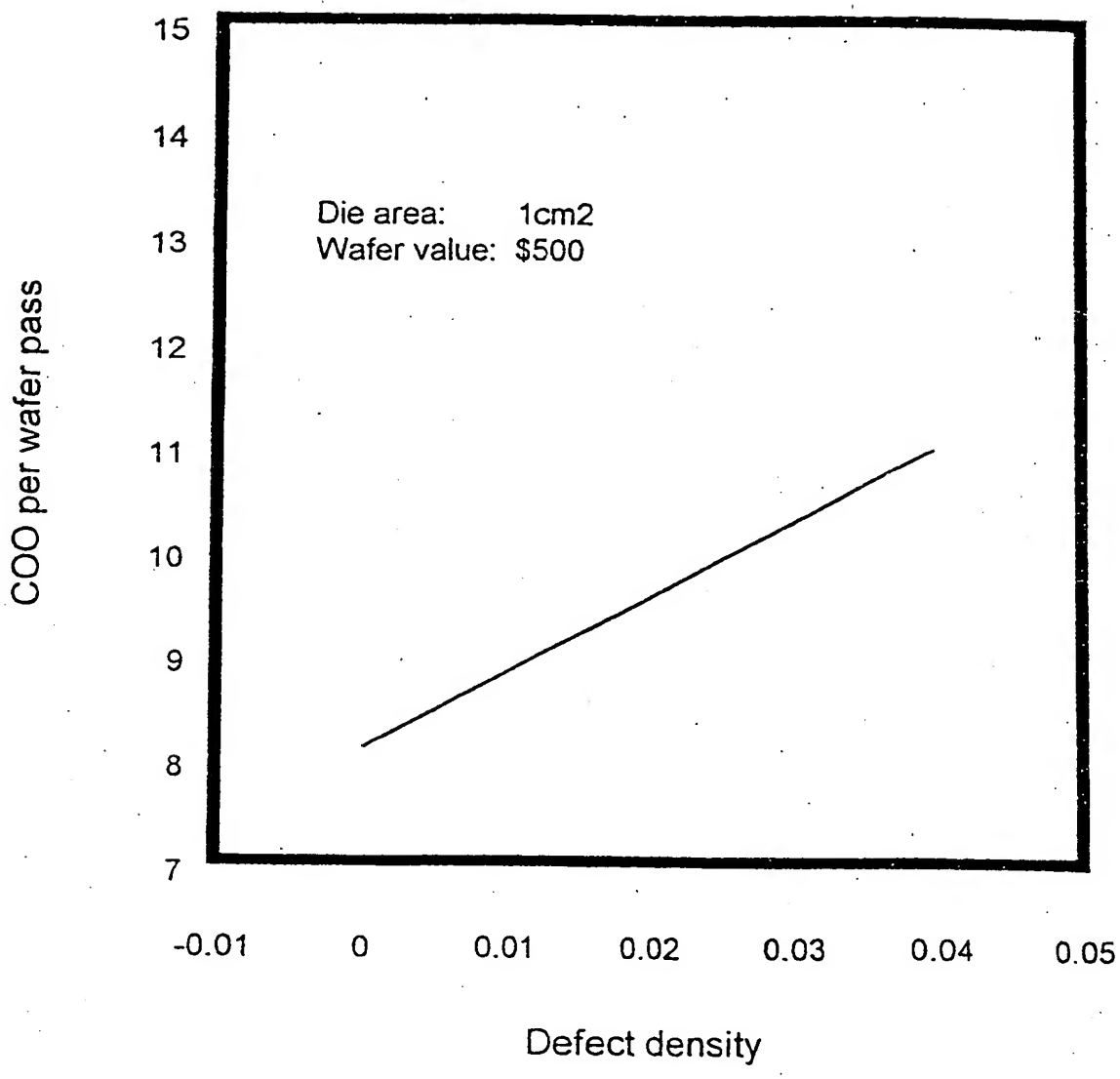

15
14
13
12
11
10
9
8
7
Die area: 1cm2
Wafer value: $500
COO per wafer pass
-0.01
0
0.01
0.02
0.03
0.04
0.05
Defect density

Figure 14

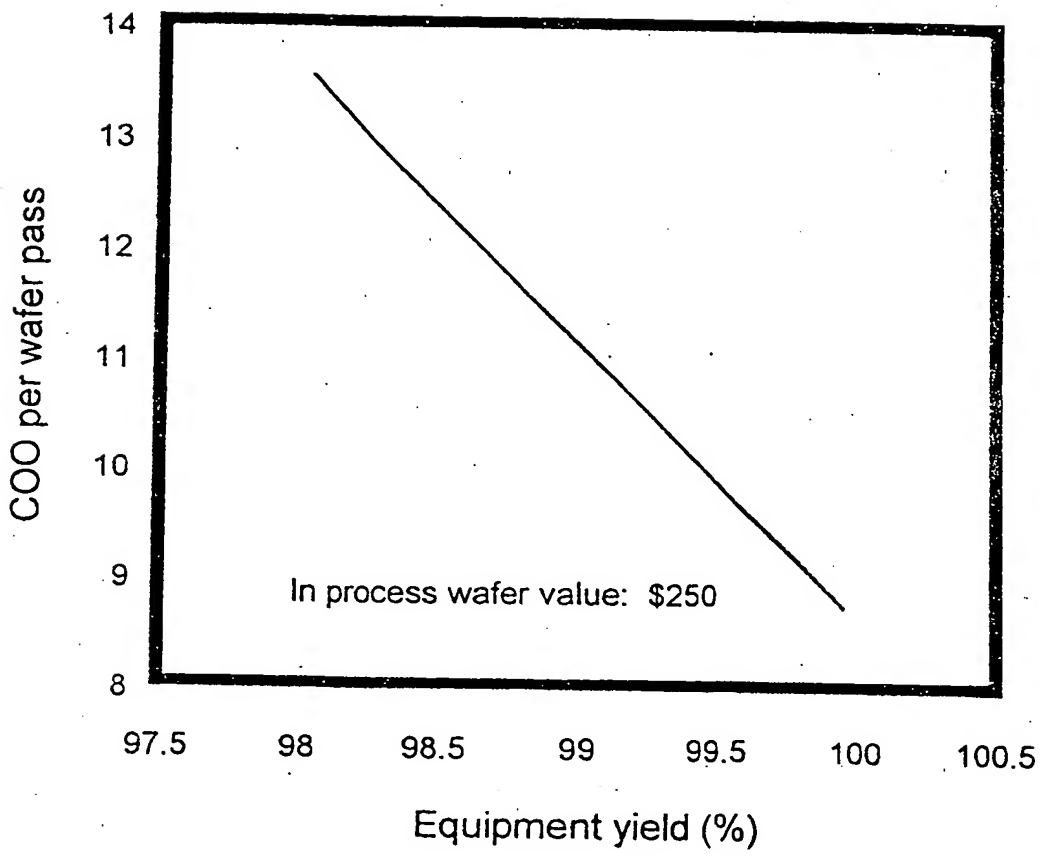

14
13
12
11
10
9
8
COO per wafer pass
In process wafer value: $250
97.5
98
98.5
99
99.5
100
100.5
Equipment yield (%)

Figure 15

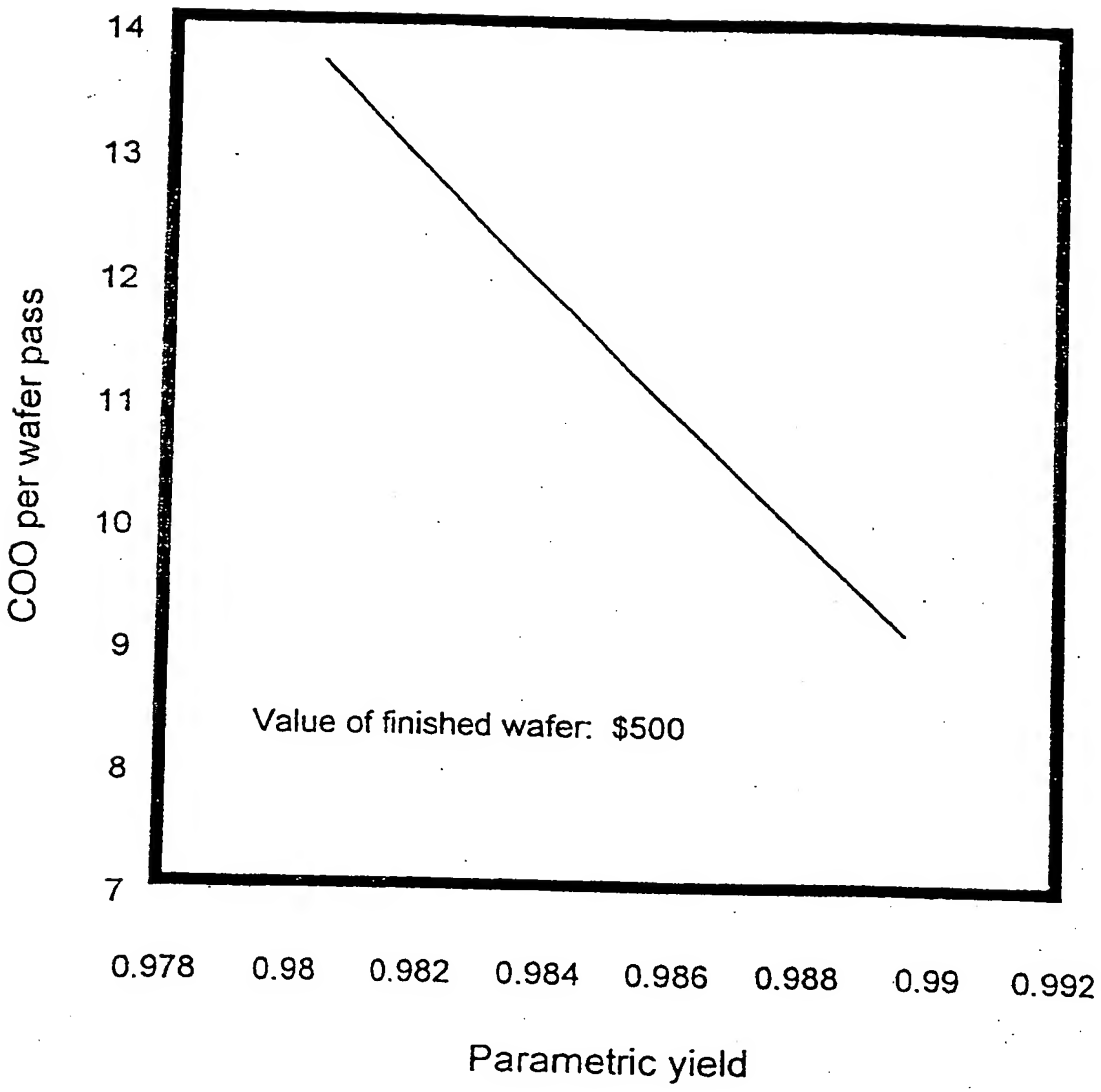
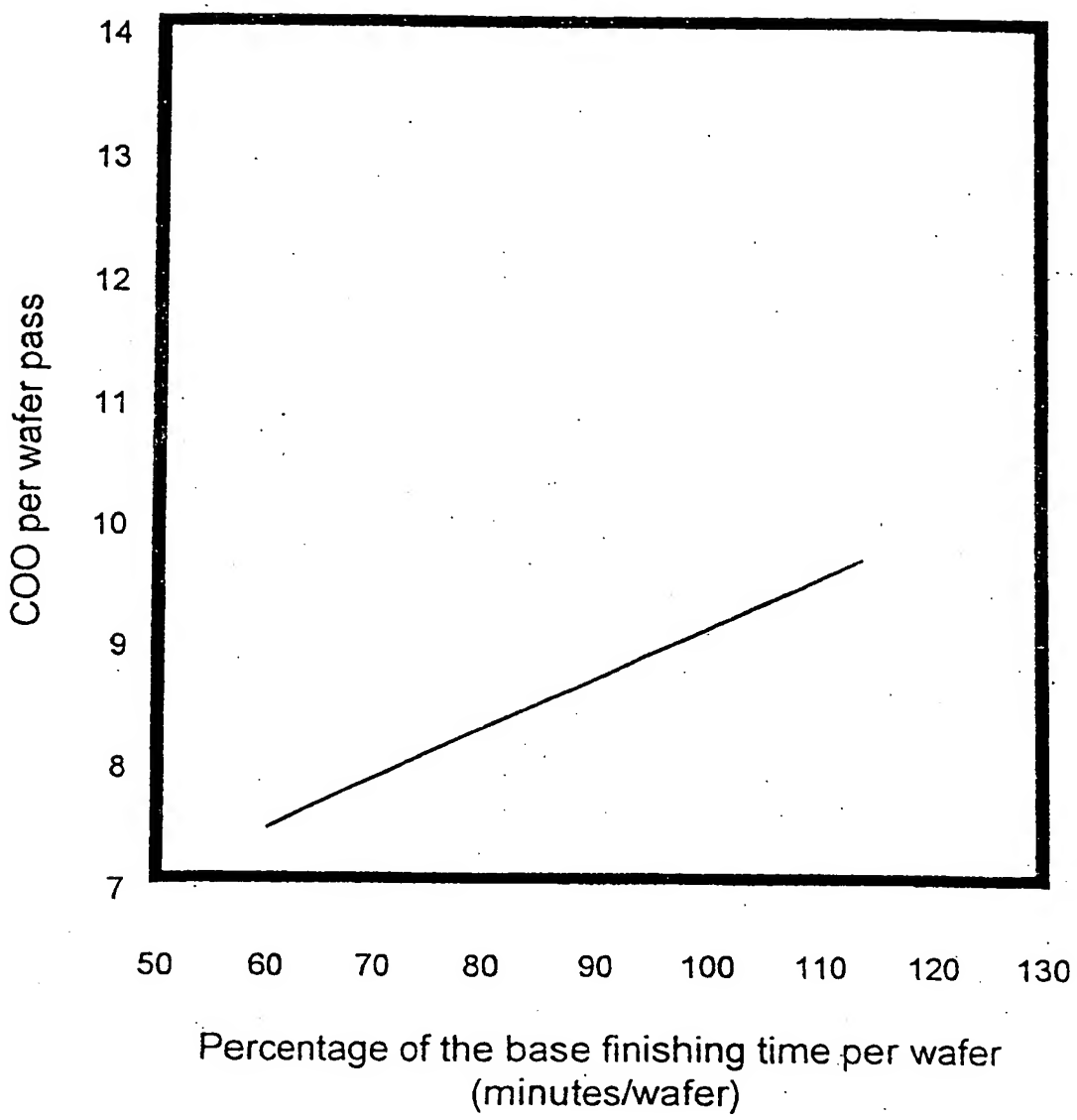

14
13
12
11
10
9
8
7
COO per wafer pass
Value of finished wafer: $500
0.978
0.98
0.982
0.984
0.986
0.988
0.99
0.992
Parametric yield

Figure 16


14
13
12
11
10
9
8
7
COO per wafer pass
50
60
70
80
90
100
110
120
130
Percentage of the base finishing time per wafer
(minutes/wafer)

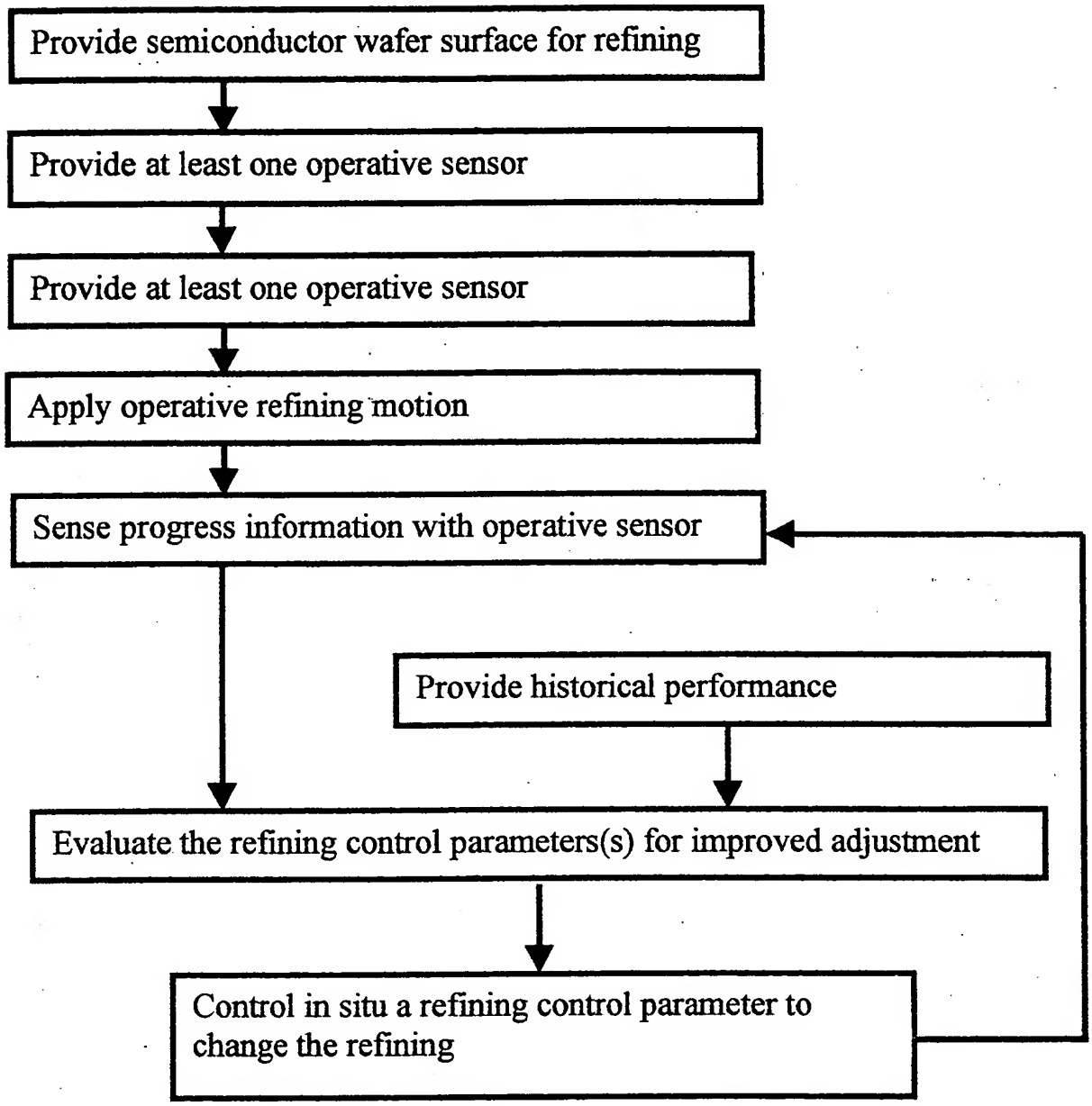

Provide semiconductor wafer surface for refining
Provide at least one operative sensor
Provide at least one operative sensor
Apply operative refining motion
Sense progress information with operative sensor
Provide historical performance
Evaluate the refining control parameters(s) for improved adjustment
Control in situ a refining control parameter to change the refining

Figure 17

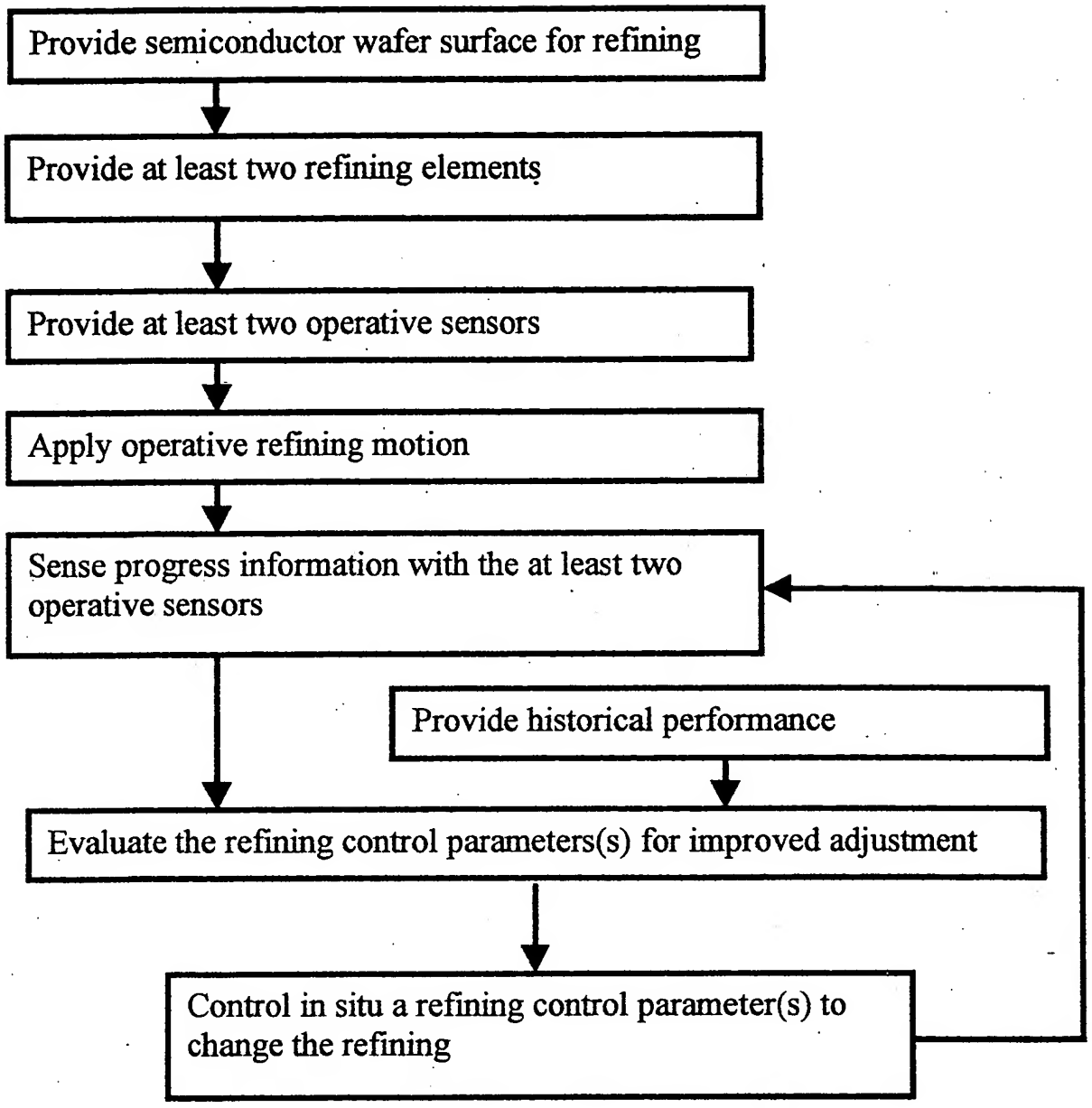

Provide semiconductor wafer surface for refining
Provide at least two refining elements
Provide at least two operative sensors
Apply operative refining motion
Sense progress information with the at least two operative sensors
Provide historical performance
Evaluate the refining control parameters(s) for improved adjustment
Control in situ a refining control parameter(s) to change the refining

Figure 18

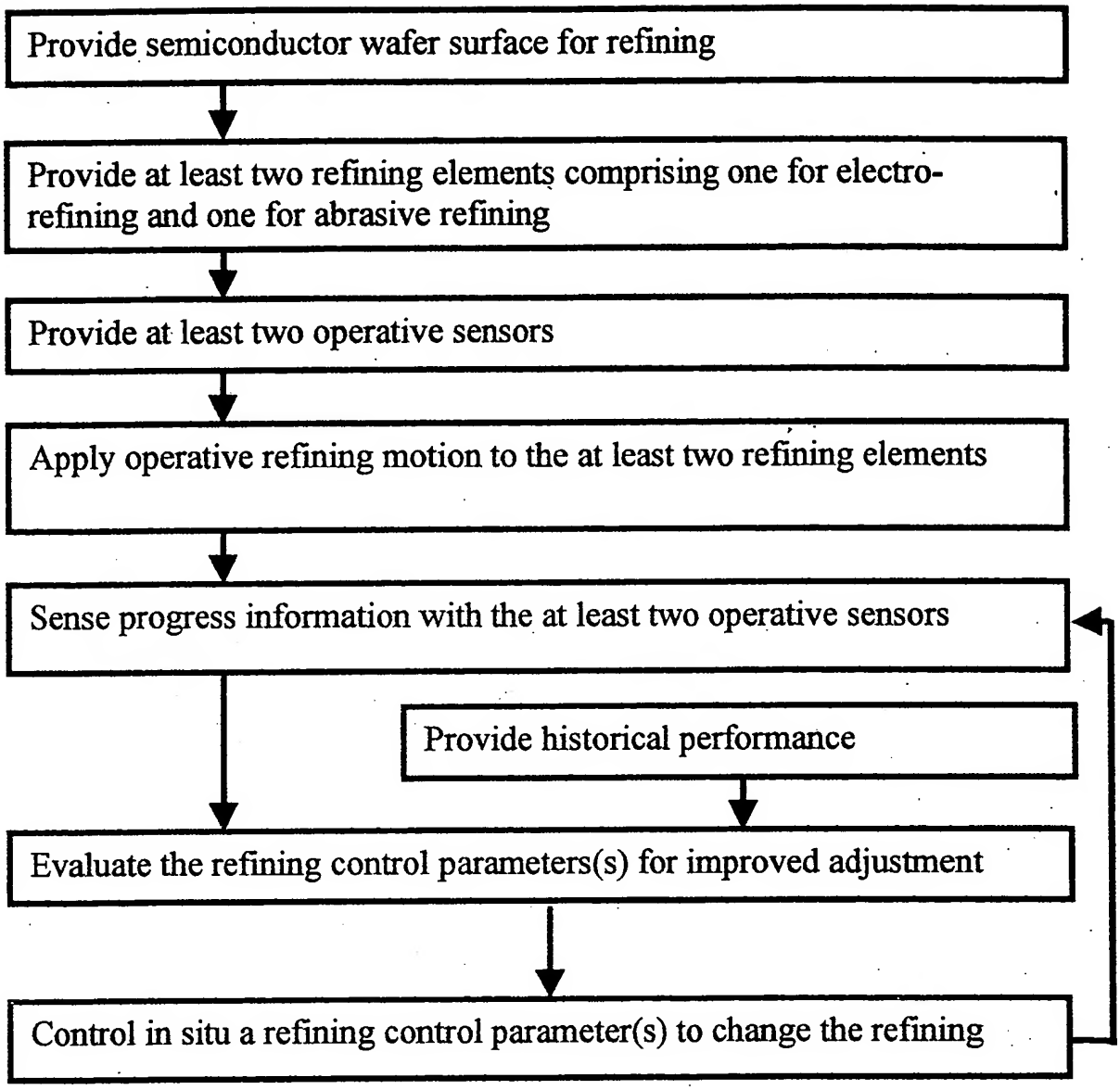

Provide semiconductor wafer surface for refining
Provide at least two refining elements comprising one for electro-refining and one for abrasive refining
Provide at least two operative sensors
Apply operative refining motion to the at least two refining elements
Sense progress information with the at least two operative sensors
Provide historical performance
Evaluate the refining control parameters(s) for improved adjustment
Control in situ a refining control parameter(s) to change the refining

Figure 19

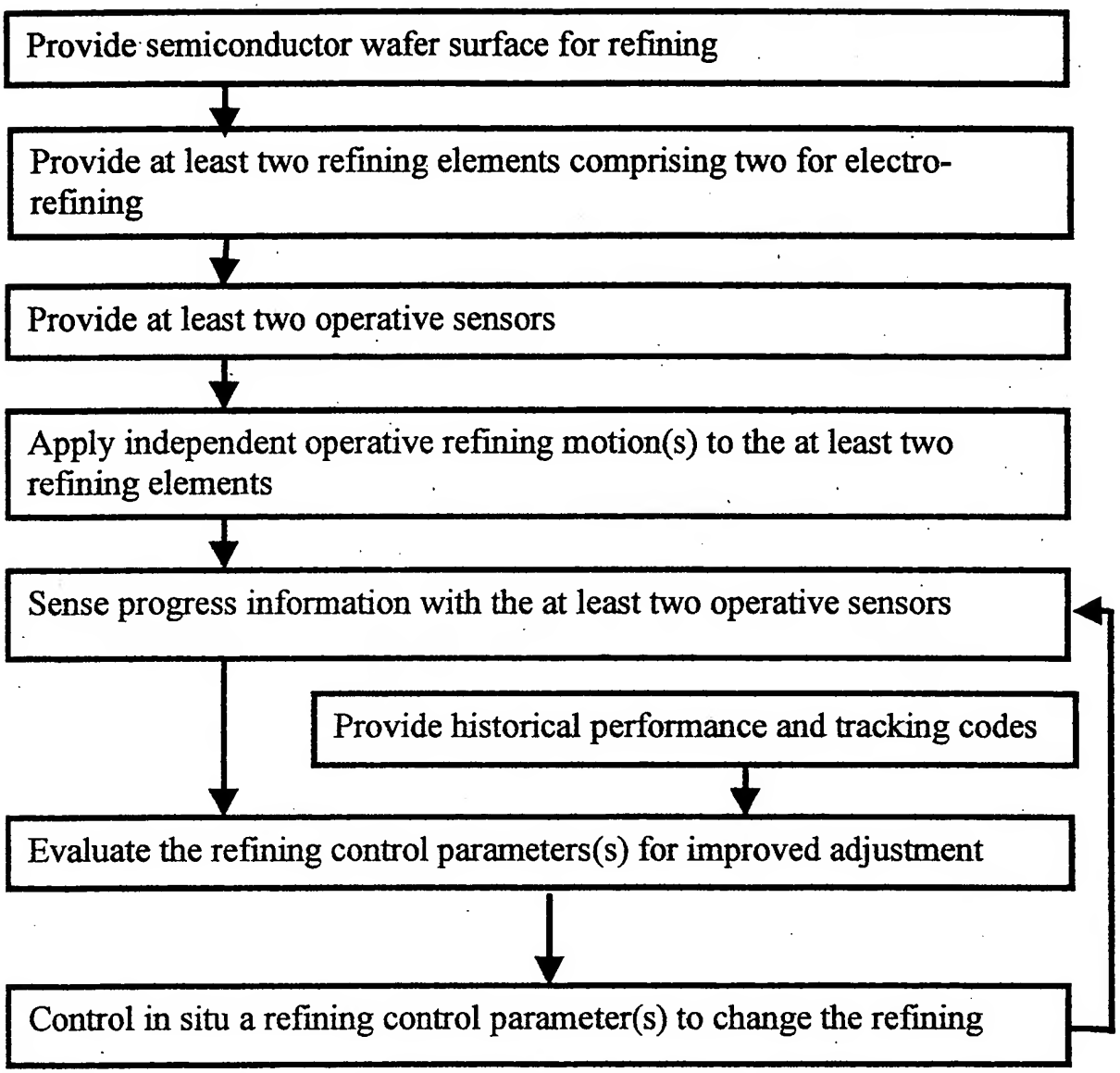

Provide semiconductor wafer surface for refining
Provide at least two refining elements comprising two for electro-refining
Provide at least two operative sensors
Apply independent operative refining motion(s) to the at least two refining elements
Sense progress information with the at least two operative sensors
Provide historical performance and tracking codes
Evaluate the refining control parameters(s) for improved adjustment
Control in situ a refining control parameter(s) to change the refining

Figure 20

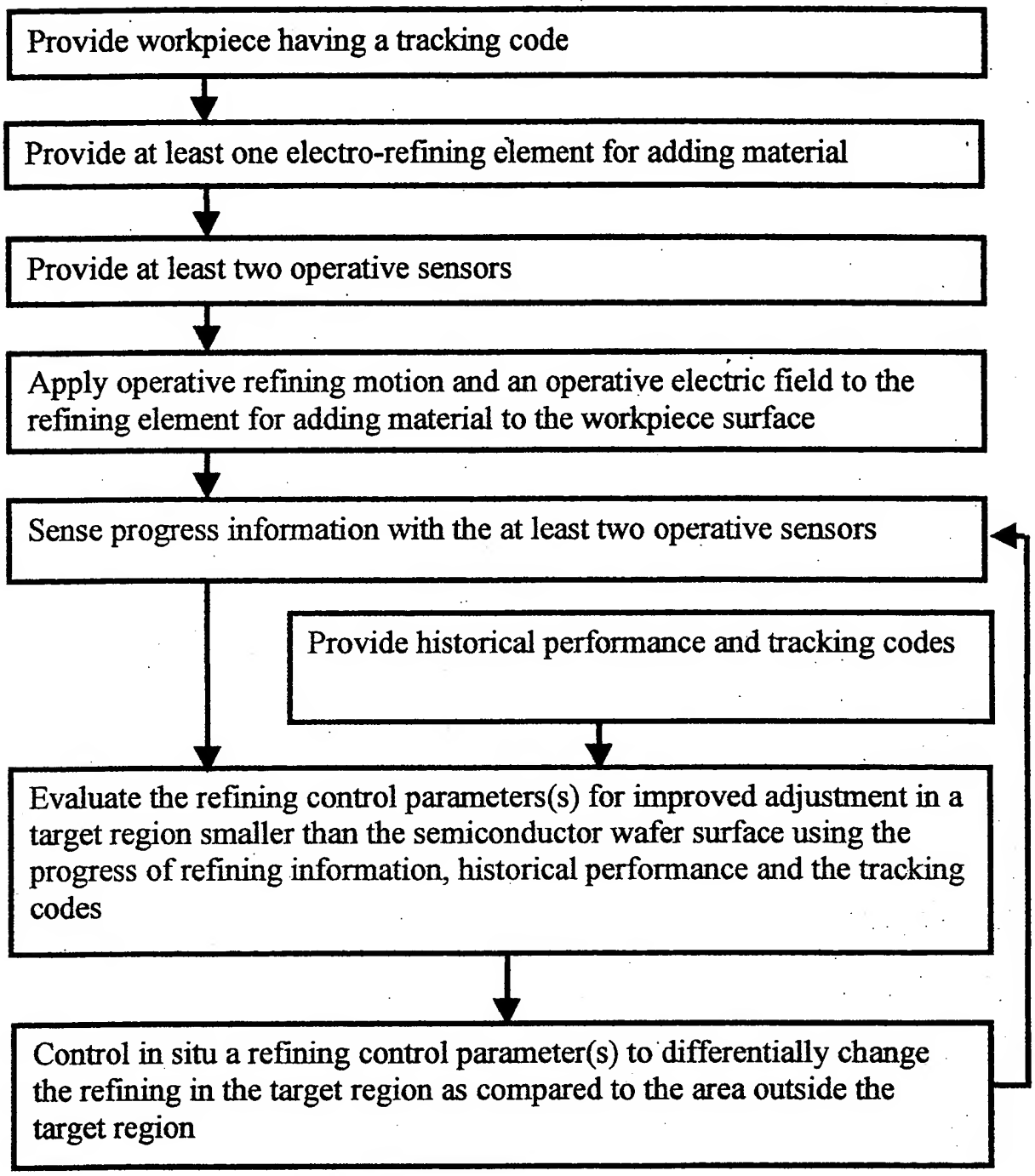

Provide workpiece having a tracking code
Provide at least one electro-refining element for adding material
Provide at least two operative sensors
Apply operative refining motion and an operative electric field to the refining element for adding material to the workpiece surface
Sense progress information with the at least two operative sensors
Provide historical performance and tracking codes
Evaluate the refining control parameters(s) for improved adjustment in a target region smaller than the semiconductor wafer surface using the progress of refining information, historical performance and the tracking codes
Control in situ a refining control parameter(s) to differentially change the refining in the target region as compared to the area outside the target region

Figure 21

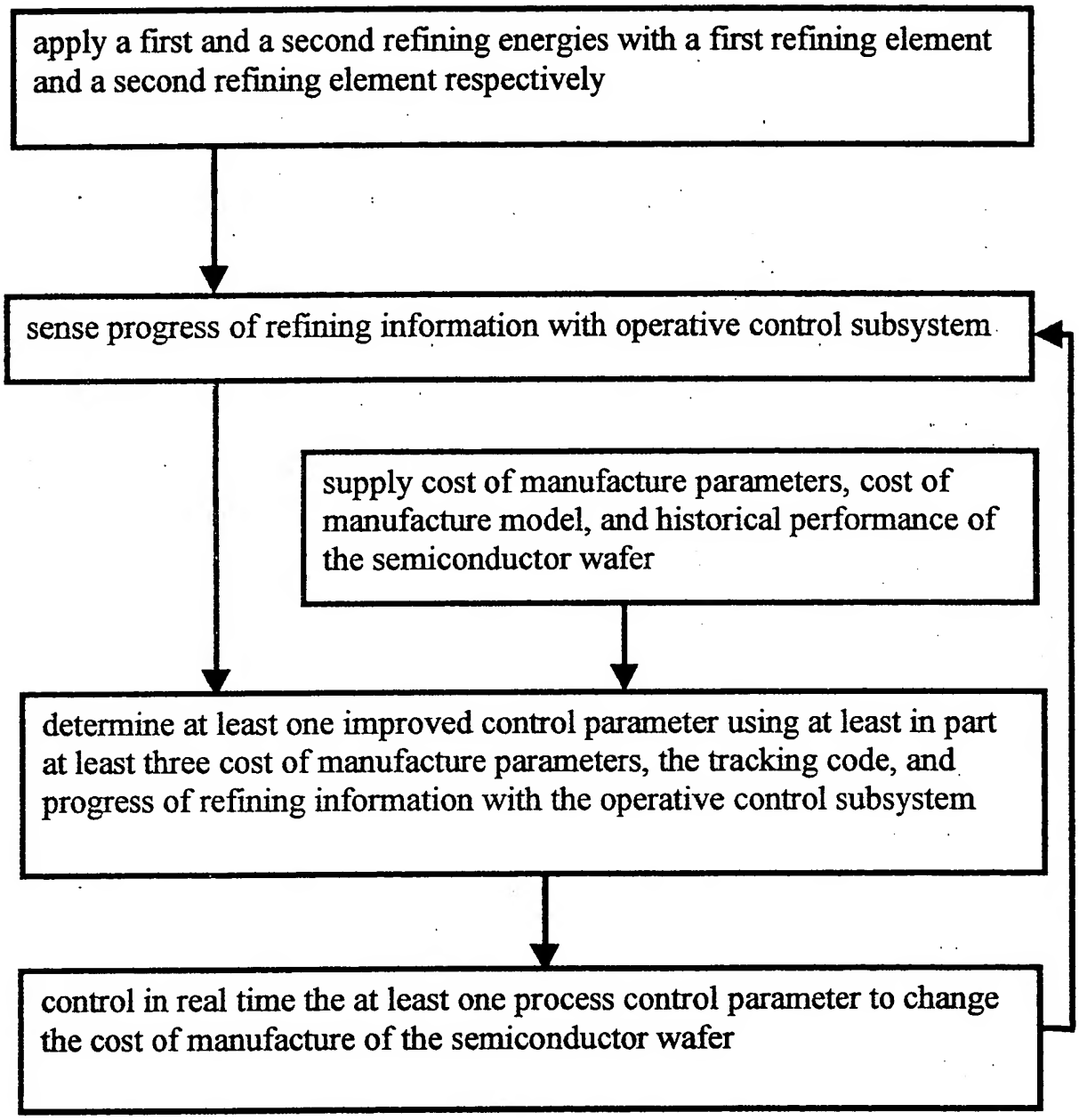

apply a first and a second refining energies with a first refining element and a second refining element respectively
sense progress of refining information with operative control subsystem
supply cost of manufacture parameters, cost of manufacture model, and historical performance of the semiconductor wafer
determine at least one improved control parameter using at least in part at least three cost of manufacture parameters, the tracking code, and progress of refining information with the operative control subsystem
control in real time the at least one process control parameter to change the cost of manufacture of the semiconductor wafer

Figure 22

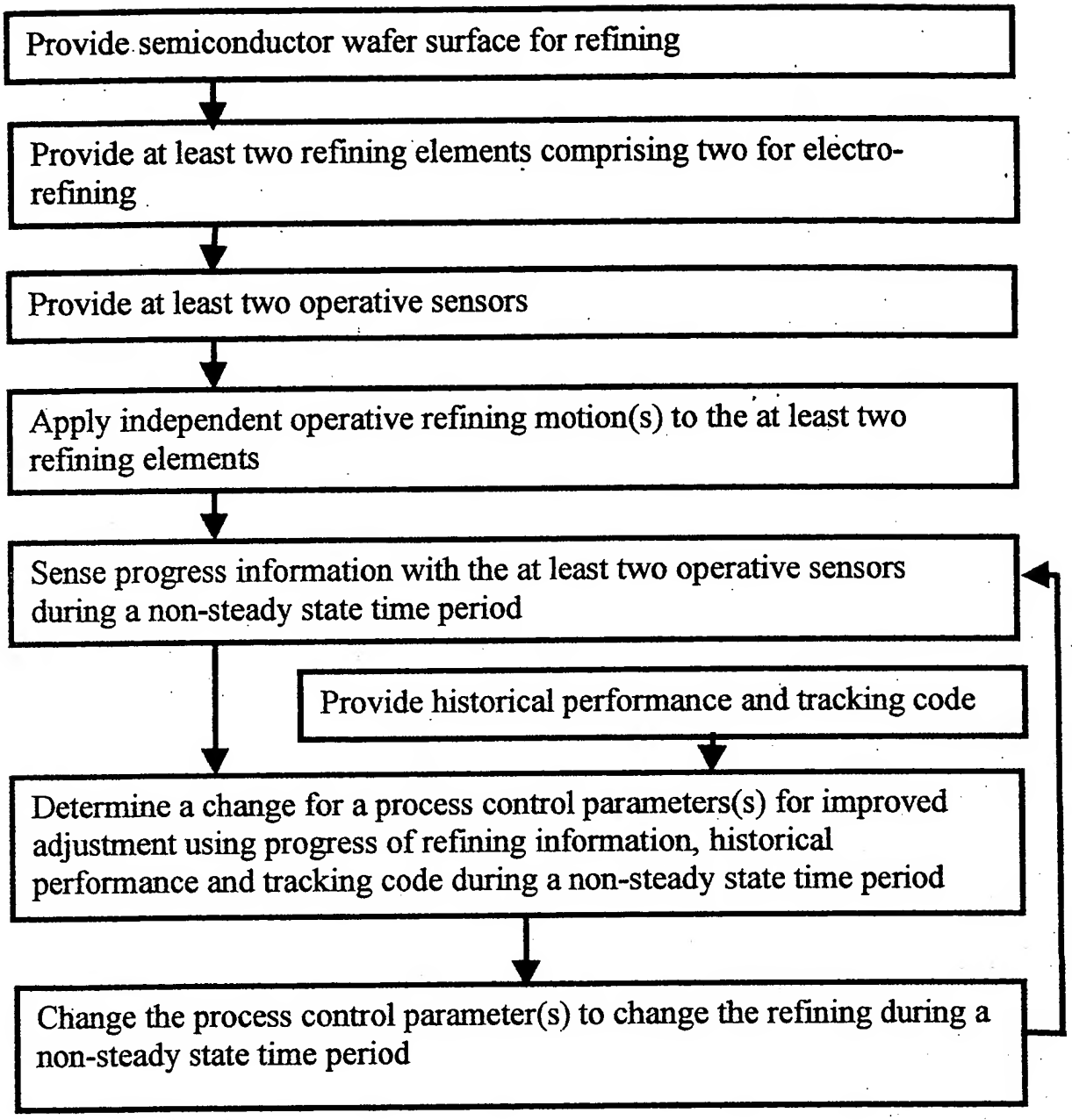

Provide semiconductor wafer surface for refining
Provide at least two refining elements comprising two for electro-refining
Provide at least two operative sensors
Apply independent operative refining motion(s) to the at least two refining elements
Sense progress information with the at least two operative sensors during a non-steady state time period
Provide historical performance and tracking code
Determine a change for a process control parameters(s) for improved adjustment using progress of refining information, historical performance and tracking code during a non-steady state time period
Change the process control parameter(s) to change the refining during a non-steady state time period

Figure 23

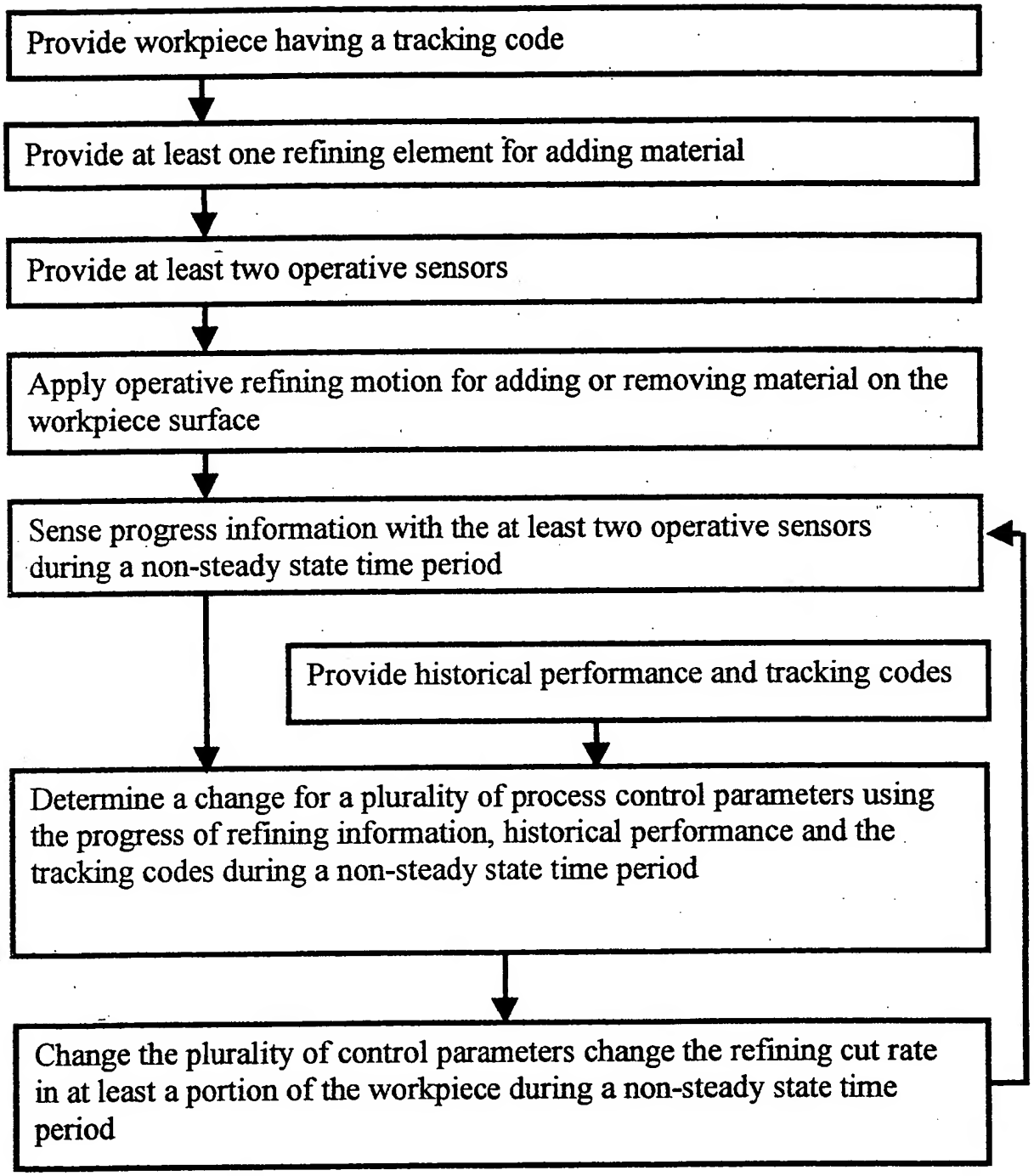

Provide workpiece having a tracking code
Provide at least one refining element for adding material
Provide at least two operative sensors
Apply operative refining motion for adding or removing material on the workpiece surface
Sense progress information with the at least two operative sensors during a non-steady state time period
Provide historical performance and tracking codes
Determine a change for a plurality of process control parameters using the progress of refining information, historical performance and the tracking codes during a non-steady state time period
Change the plurality of control parameters change the refining cut rate in at least a portion of the workpiece during a non-steady state time period

Figure 24

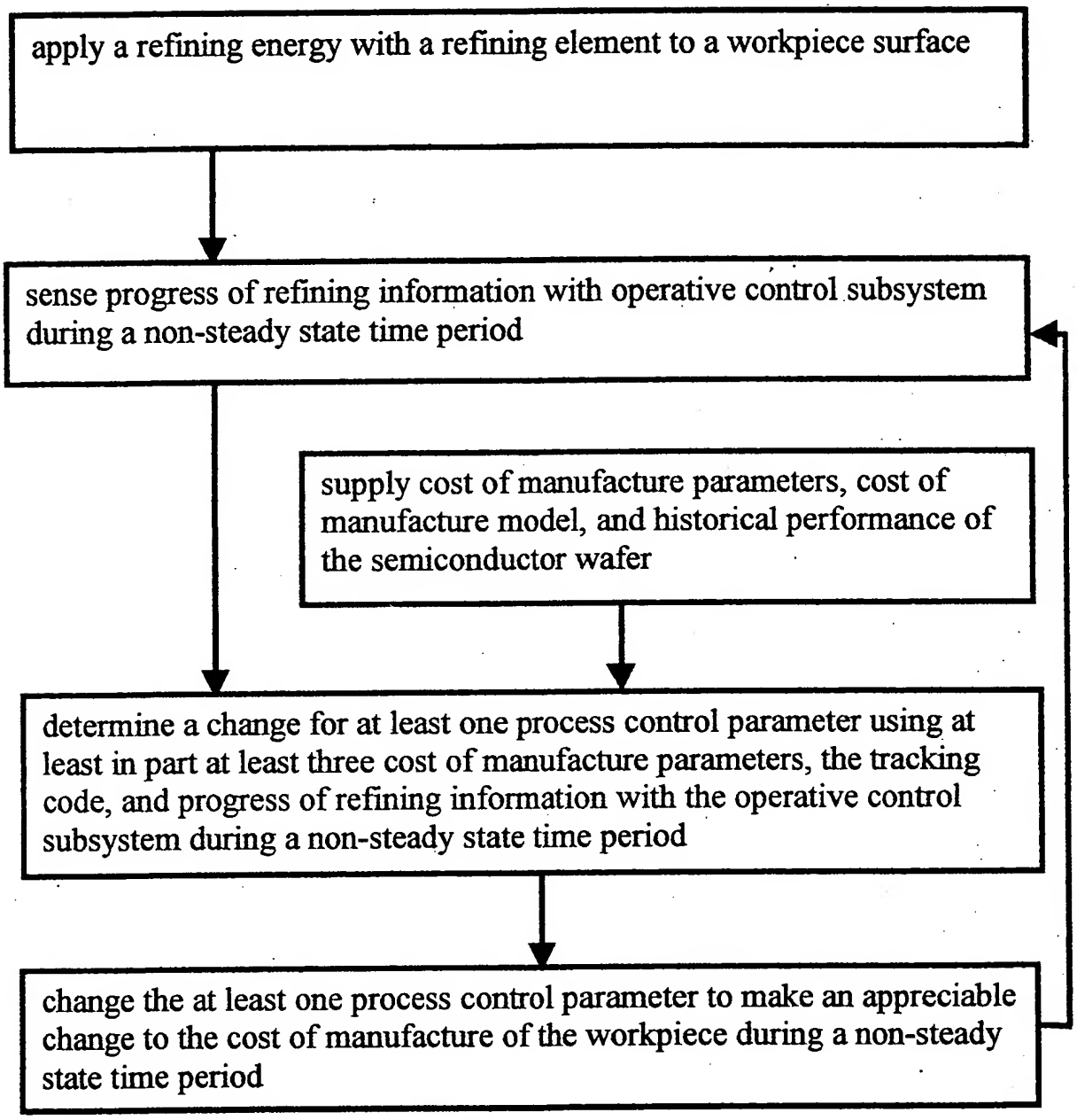

apply a refining energy with a refining element to a workpiece surface
sense progress of refining information with operative control subsystem during a non-steady state time period
supply cost of manufacture parameters, cost of manufacture model, and historical performance of the semiconductor wafer
determine a change for at least one process control parameter using at least in part at least three cost of manufacture parameters, the tracking code, and progress of refining information with the operative control subsystem during a non-steady state time period
change the at least one process control parameter to make an appreciable change to the cost of manufacture of the workpiece during a non-steady state time period

Figure 25

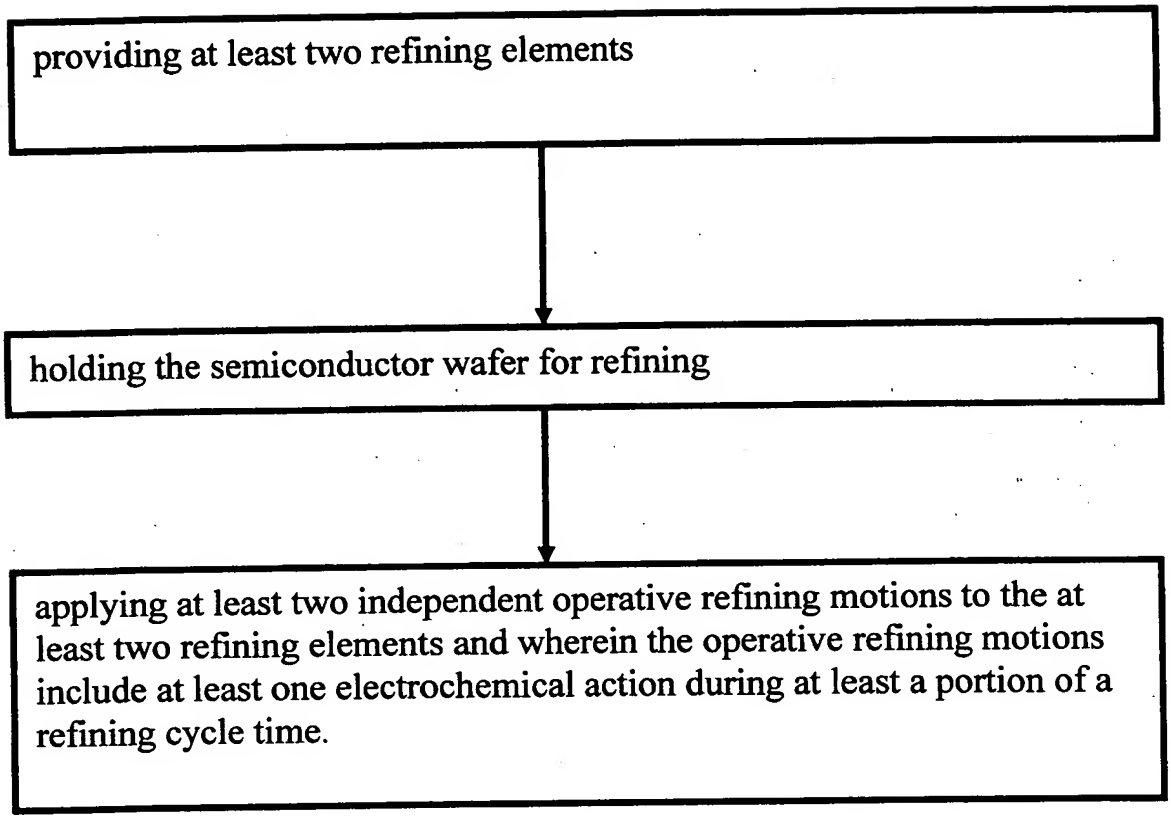

providing at least two refining elements
holding the semiconductor wafer for refining
applying at least two independent operative refining motions to the at least two refining elements and wherein the operative refining motions include at least one electrochemical action during at least a portion of a refining cycle time.

Figure 26

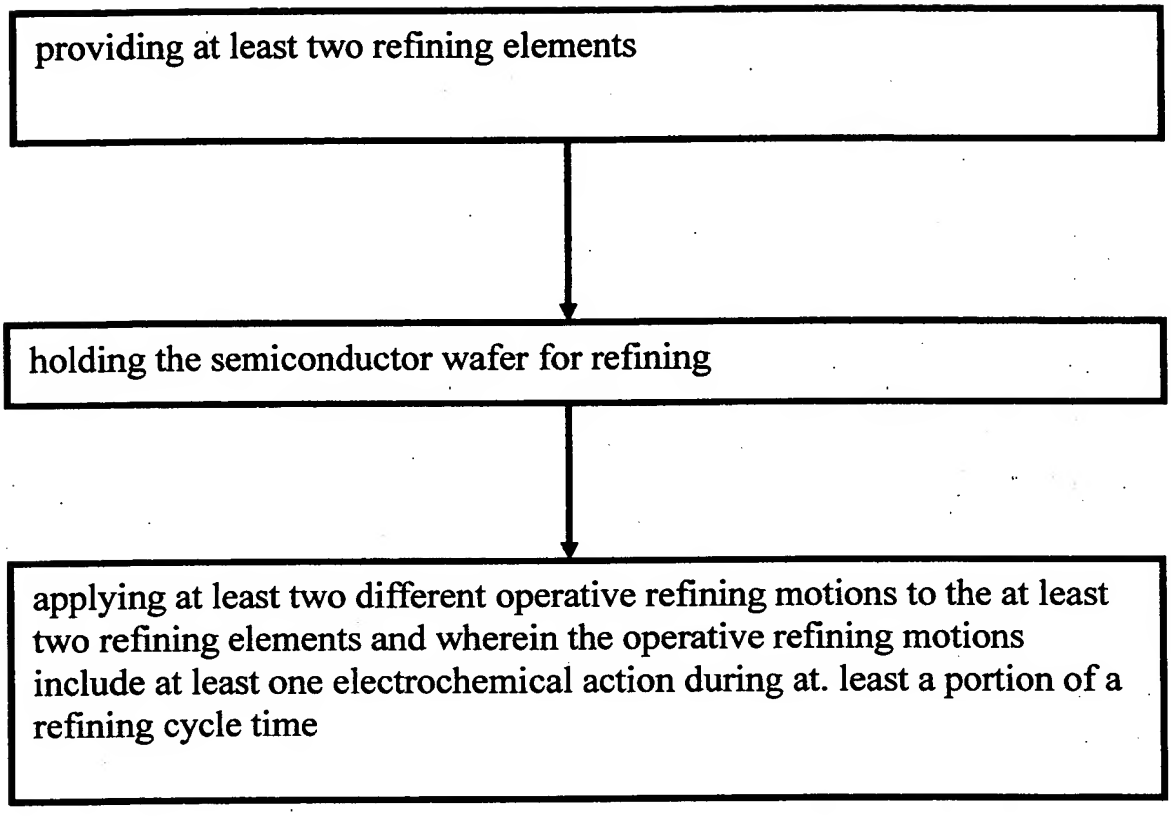

providing at least two refining elements
holding the semiconductor wafer for refining
applying at least two different operative refining motions to the at least two refining elements and wherein the operative refining motions include at least one electrochemical action during at. least a portion of a refining cycle time

Figure 27

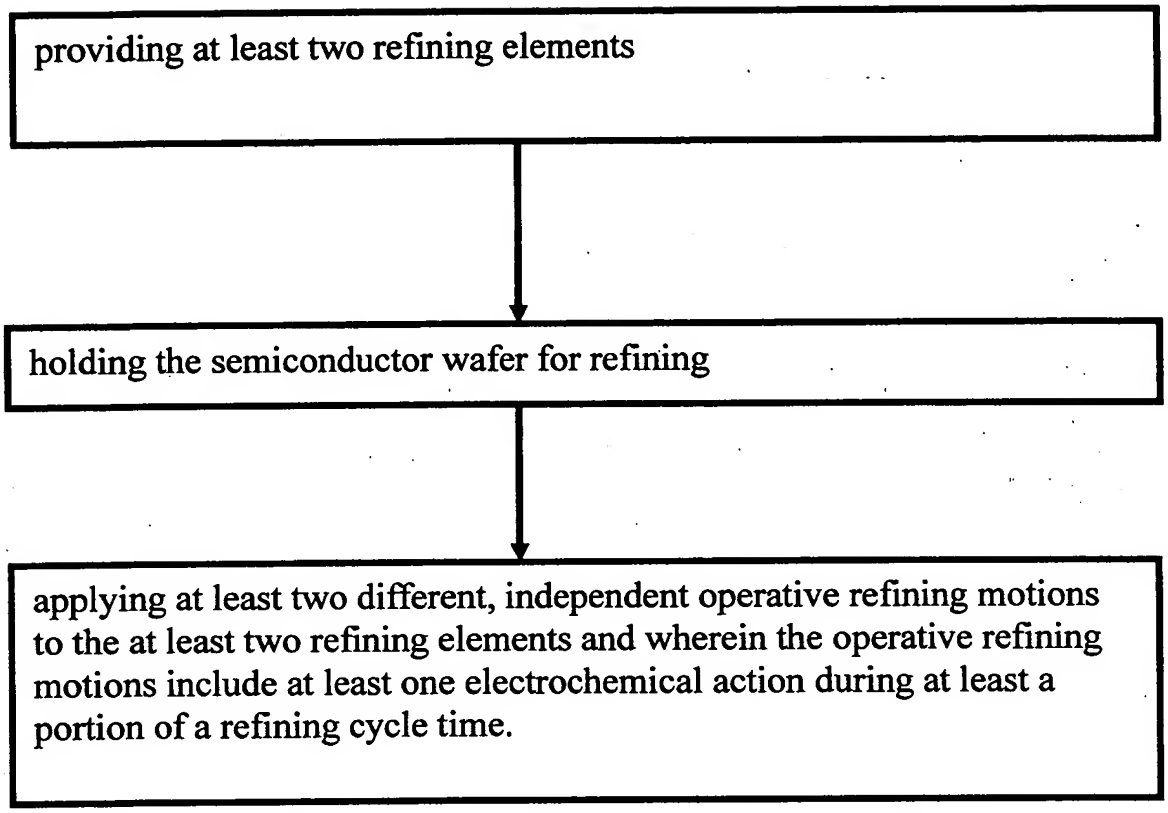

providing at least two refining elements
holding the semiconductor wafer for refining
applying at least two different, independent operative refining motions to the at least two refining elements and wherein the operative refining motions include at least one electrochemical action during at least a portion of a refining cycle time.

Figure 28

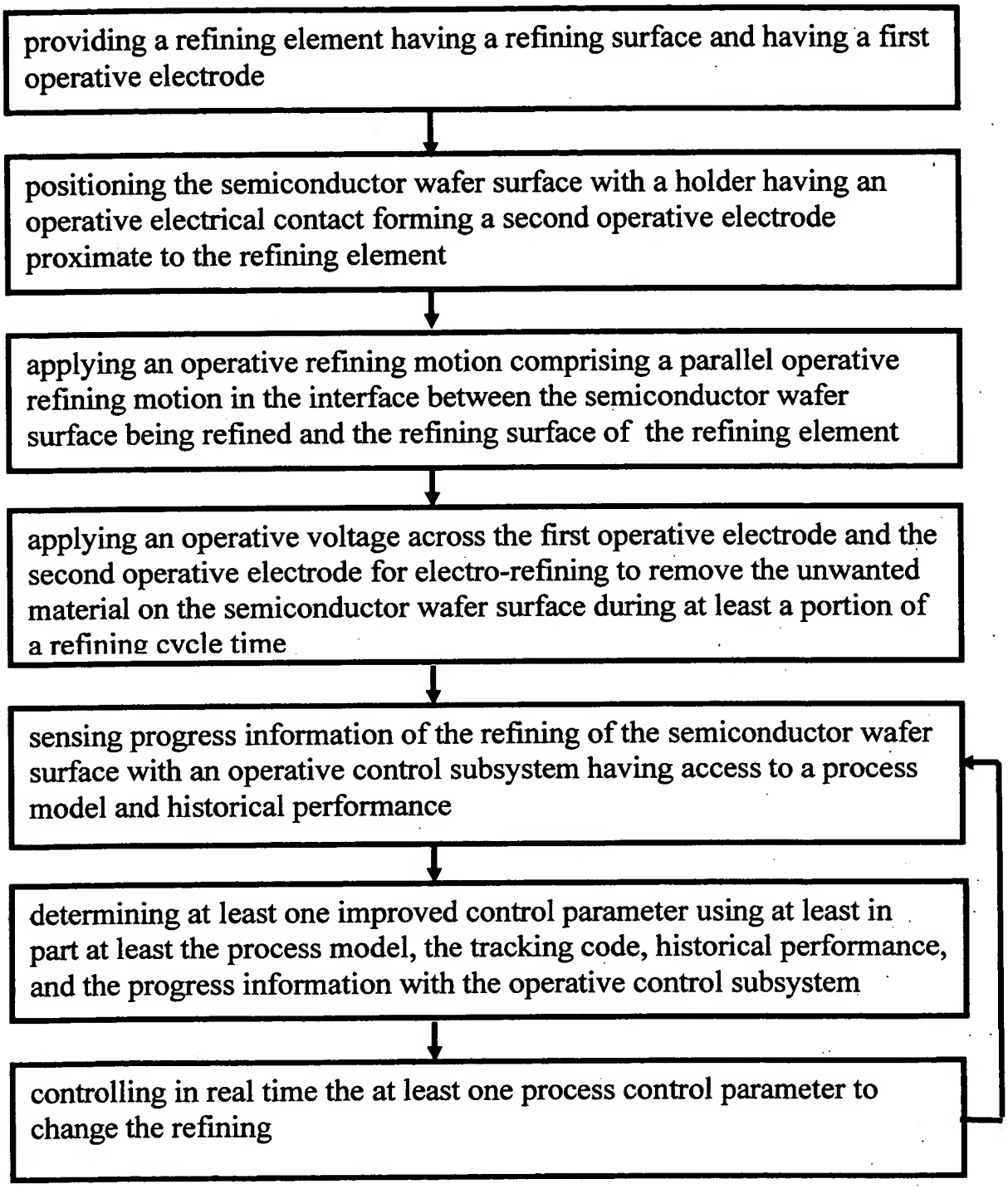

providing a refining element having a refining surface and having a first operative electrode
positioning the semiconductor wafer surface with a holder having an operative electrical contact forming a second operative electrode proximate to the refining element
applying an operative refining motion comprising a parallel operative refining motion in the interface between the semiconductor wafer surface being refined and the refining surface of the refining element
applying an operative voltage across the first operative electrode and the second operative electrode for electro-refining to remove the unwanted material on the semiconductor wafer surface during at least a portion of a refining cycle time
sensing progress information of the refining of the semiconductor wafer surface with an operative control subsystem having access to a process model and historical performance
determining at least one improved control parameter using at least in part at least the process model, the tracking code, historical performance, and the progress information with the operative control subsystem
controlling in real time the at least one process control parameter to change the refining

Figure 29

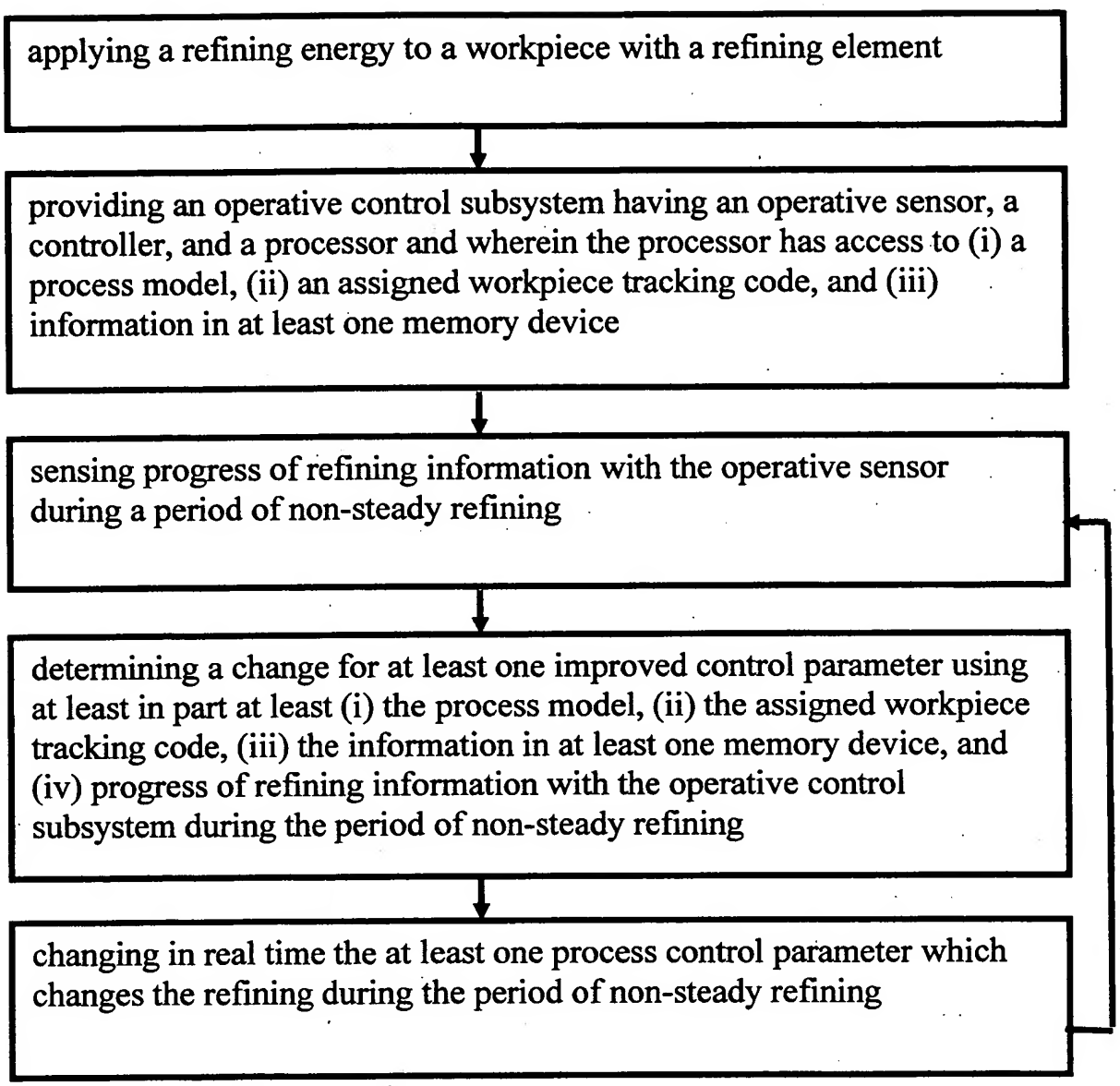

applying a refining energy to a workpiece with a refining element
providing an operative control subsystem having an operative sensor, a controller, and a processor and wherein the processor has access to (i) a process model, (ii) an assigned workpiece tracking code, and (iii) information in at least one memory device
sensing progress of refining information with the operative sensor during a period of non-steady refining
determining a change for at least one improved control parameter using at least in part at least (i) the process model, (ii) the assigned workpiece tracking code, (iii) the information in at least one memory device, and (iv) progress of refining information with the operative control subsystem during the period of non-steady refining
changing in real time the at least one process control parameter which changes the refining during the period of non-steady refining

Figure 30

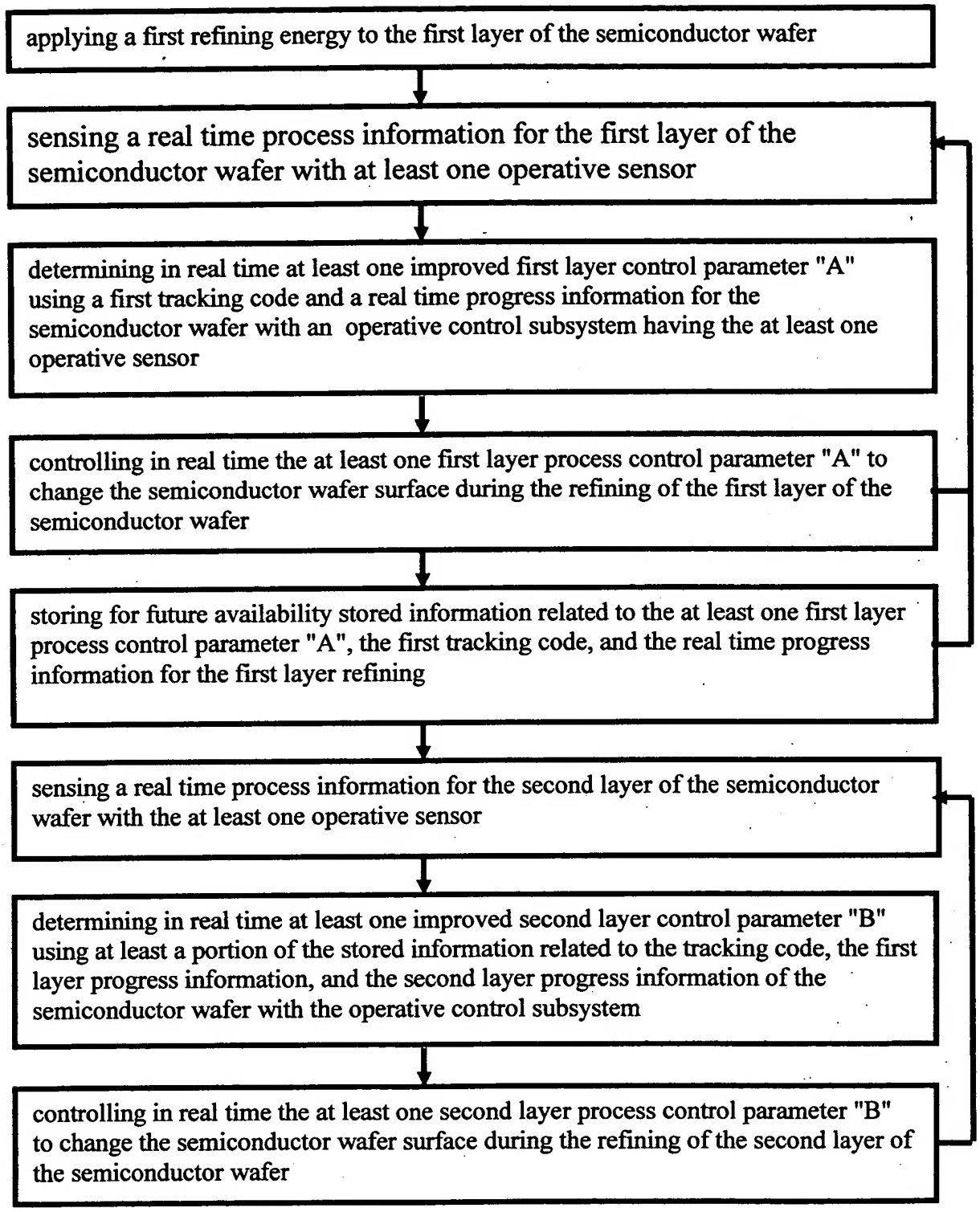

applying a first refining energy to the first layer of the semiconductor wafer
sensing a real time process information for the first layer of the semiconductor wafer with at least one operative sensor
determining in real time at least one improved first layer control parameter "A" using a first tracking code and a real time progress information for the semiconductor wafer with an operative control subsystem having the at least one operative sensor
controlling in real time the at least one first layer process control parameter "A" to change the semiconductor wafer surface during the refining of the first layer of the semiconductor wafer
storing for future availability stored information related to the at least one first layer process control parameter "A", the first tracking code, and the real time progress information for the first layer refining
sensing a real time process information for the second layer of the semiconductor wafer with the at least one operative sensor
determining in real time at least one improved second layer control parameter "B" using at least a portion of the stored information related to the tracking code, the first layer progress information, and the second layer progress information of the semiconductor wafer with the operative control subsystem
controlling in real time the at least one second layer process control parameter "B" to change the semiconductor wafer surface during the refining of the second layer of the semiconductor wafer

Figure 31